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PASSING THROUGH A PANAMA CANAL LOCK
Additional Water for Lockages Will Be Stored by the Madden Dam

Volume 2 ~ Number 5 ~

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

MAY 1932

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Among Our Writers

E. S. RANDOLPH began his engineering career in 1910 with the Panama Railroad Company, when the railroad was being relocated from a position through the present Gatun Lake to higher ground, and continued with it during the construction of the ocean piers on the Atlantic Terminal of the Canal. He next took part in the building of the permanent shops and dry docks for the Canal. For six years he was in charge of all designs for new structures for the Canal. In 1929 he was appointed Designing Engineer, and in 1931, Construction Engineer, on the Madden Dam Project. During his connection with the Panama Canal, he has been called in as consulting engineer to the Republics of Panama, of Colombia, and of Nicaragua.

GEORGE G. EARL was for 31 years General Superintendent of the Sewerage and Water Board of New Orleans and is therefore well fitted to speak on the problems of the city in these fields. In 1918 Lafayette College, Easton, Pa., conferred on him the degree of Doctor of Science. In 1931 he organized the Earl Engineering Company to engage in engineering practice, and since that date has been Advisory Engineer for the Sewerage and Water Board of New Orleans.

HIBBERT M. HILL graduated from the University of Minnesota in 1923 with the degree of B.S. in Civil Engineering. After spending a short time with the U.S. Coast and Geodetic Survey, he returned to Minnesota to teach hydraulic engineering for about four years. Since 1928 he has been in the U.S. Engineer Office at St. Paul, in charge of the operation of the United States reservoirs at the headwaters of the Mississippi, and of various engineering studies, including the report on the canalization of the upper river.

RALPH P. JOHNSON graduated from the University of Minnesota in 1928 with the degree of B.S. in Civil Engineering. He then served about six months with the Pennsylvania Railroad and about two years with contracting organizations building highways. In 1930, he entered the Government service in the U.S. Engineer Office at St. Paul. Since 1930 he has been in charge of the maintenance work on the Government reservoirs at the headwaters of the Mississippi.

ROBERT M. MILLER served in the A.E.F. as Captain of Engineers and was Civil Engineer of the Port of St. Nazaire, France. Returning to the United States, he was Resident Engineer in charge of construction of the Virginian and Western Railway and of the company's coal pier No. 2 at Sewall's Point, Va. After a connection with the Cincinnati Union Terminal Project he became Chief Engineer of the Holmes Construction Company, Cincinnati, builders of roads and railroads. He has held his present position since 1930.

J. W. BERETTA, after receiving his B.S. in Architectural Engineering at the Massachusetts Institute of Technology in 1923, was employed by the American Bridge Company, serving as Resident Engineer on the erection of the Delaware River Bridge, Philadelphia. For two years he was Assistant Engineer and Bridge Designer in the New York office of this company. In 1927, he established the firm of J. W. Beretta Engineers, Inc., of San Antonio, Tex., having a general consulting practice. For the past three years he has been Governor for Texas of the National Aeronautic Association.

P. A. WELTY has had wide experience in irrigation work in the West and Southwest. He was Supervising Engineer of the Sacramento Valley Irrigation Company when 180,000 acres were subdivided into 40-acre units, and later served as Engineer and Supervisor of the 70,000-acre irrigation district at San Benito, Tex. In 1919, he examined for the U.S. Reclamation Service the lands offered by Texas and Florida as farms for war veterans. He served both as Locating Engineer and as Chief Engineer on construction and operation of the 100,000-acre Wichita County Water Improvement District No. 1; and has held positions of similar responsibility in Texas on the Brownwood and Medina irrigation projects. He has also maintained a consulting practice.

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VOLUME 2

NUMBER 5

More Water for the Panama Canal

Provided by the Madden Dam Project Now Under Construction on the Chagres River

By E. S. RANDOLPH
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSTRUCTION ENGINEER, MADDEN DAM PROJECT, CANAL ZONE

TONNAGE through the Panama Canal, which is growing at the rate of 1,000,000 tons per year, in 1930 reached nearly 30,000,000 tons. Since each lockage either way from Gatun Lake, the peak elevation of the Canal, releases about 150 acre-ft. of water to the sea, it is estimated that this growth in tonnage will require an additional water supply of 30,000 acre-ft. annually. When completed, the Madden Dam across the Chagres River above Gatun Lake will supply any deficiency, with its half million acre-feet of usable storage capacity. An additional 250,000 acre-ft. of storage will be provided to regulate floods on the Chagres River.

Madden Dam is to be built as a massive gravity overflow section, topped by four 100-ft. drum gates. Because of the geological formations at the dam site and in the reservoir area very complete core borings were made to locate fissures, seams, and caverns in the sandstone and limestone. These are being filled with puddled clay under pressure. Above the dam itself a thick clay blanket will be sluiced into place to increase the length of the percolation path. The dam is designed to resist earthquake shock in accordance with the latest theoretical analysis. A power plant containing three 11,200-hp. hydraulic turbines is to be built on the left bank as an integral part of the dam. The construction contract, awarded late in 1931, allows the contractor 1,350 days for completion.

The dam was named for the late Congressman Martin B. Madden, who in 1900 wrote the plank which committed his party to support construction of the Panama Canal. The paper from which this article was prepared was read by Mr. Randolph before the Panama Section of the Society on October 20, 1931.

THE Madden Dam Project, the largest single project on the Panama Canal since its completion, has a threefold purpose: first, to increase the reserve water supply for the maintenance of depths adequate for navigation during the dry season, which extends throughout the first four months of the year; second, to provide additional hydro-electric power for use in operating the locks; and third, to control the floods of the Chagres River. The dam will be situated at a point formerly called Alhajuela, which is on the Chagres River about 12 miles above its junction with the Canal in Lake Gatun. The location of the reservoir is shown in Fig. 1.

The need for a dam at this place was foreseen by the French, who made surveys and geological and engineering studies for it prior to the occupation of the Zone by the

SITE OF THE MADDEN DAM, LOOKING DOWNSTREAM, DECEMBER 31, 1931

United States. They chose a site only a few hundred feet above that decided upon by the Isthmian Canal Commission after very extensive surveys, borings, bearing tests, and investigations by geologists and engineers who are experts in the subject. From the first the Commission had planned to build a dam at this place,

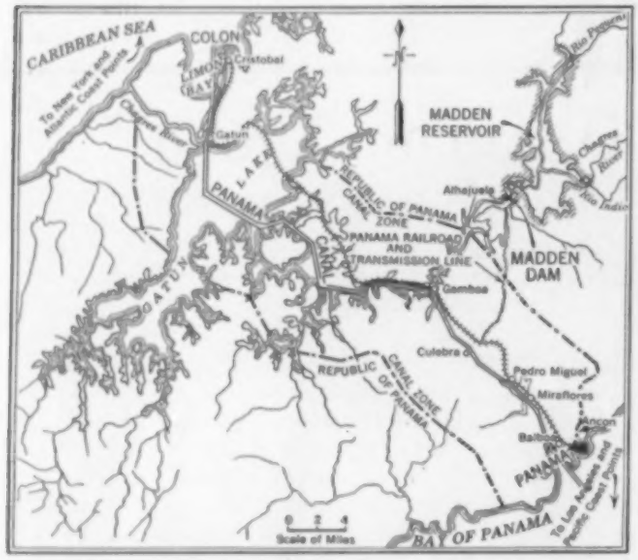


FIG. 1. THE MADDEN DAM PROJECT, CANAL ZONE

the time for its construction to be chosen so that the storage capacity of the reservoir would be available when traffic through the Canal should have grown to such an extent that the added water supply would be required. The time is now approaching when the useful storage capacity of Lake Gatun, 32 billion cubic feet, will be inadequate during the four months of the dry season, which extends approximately from January 1 to April 30.

In 1930, the annual net tonnage through the Canal had reached about 30,000,000 tons, and the indicated growth was 1,000,000 tons a year. Assuming 6,500,000 cu. ft. of water and 5,000 tons per lockage, the water used per ton will be 1,300 cu. ft., and the increase in the amount of water required for lockages alone will be at the rate of 1,300,000 000 cu. ft. per year. During the dry season, the Government is now using a Diesel-driven electric plant to supply power for the operation of the Canal, so that it is not necessary to run water through the Canal for the sole purpose of operating the present hydro-electric plant. When the Madden Dam and hydro-electric plant are completed, operation of the Diesel plant can be discontinued for many years, except for emergency service.

PRELIMINARY WORK BEGUN IN 1919

Mapping of the 20.8 square miles of the reservoir site was commenced in 1919 and the area was acquired from the Republic of Panama in 1924 under the terms of the treaty of that date. Early in 1928 a committee of engineers of the Panama Canal submitted a report on the proposed Madden Dam Project, dealing with matters of design, transportation, power, hydrography, leakage, construction program, and materials of construction. In the spring of 1929 the U.S. Geological Survey thoroughly explored the dam site by means of drill borings, trenches, and test pits. A period of intensive drilling, testing, and mapping followed. Specimens of rock were sent to the Laboratory of the Bureau of Standards, where they were subjected to thorough physical and chemical testing.

A total of 23,000 lin. ft. of diamond-drill cores was cut in solid rock. Of this number, 20,600 ft. were cut with black carbon diamonds and 2,400 with cast tungsten carbide, a substitute for the diamonds. The diamonds cost $150 per carat, but the substitute, which was set in the drill in the same way as the diamonds, cost only $1 per ounce. Cores having a diameter of more than 1 in. were found to be more satisfactory than those of smaller diameter. In the more important areas, cores of $1^{15}/_{16}$-in. diameter were taken.

Field investigations of underground conditions occupied the entire year 1930. Beneath the ridge on the right bank of the river, large caverns were discovered, one of which was 1,500 ft. long, 100 ft. wide, and 40 ft. high at maximum section. Fortunately none of the caverns are so situated as to form a direct passage for water when the reservoir is full, but to make certain of this fact it was necessary to resort to extensive use of the diamond drill and to subsurface exploration by mining methods.

Samples of rock from the foundation were tested by the University of Illinois, and their deformations under combined compressive stresses were measured. Many specimens were tested in the laboratory of the Panama Canal, some of them for elastic properties by measure-

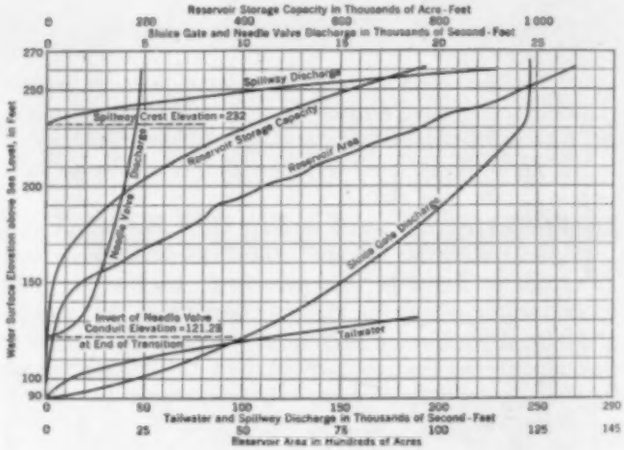

Reservoir Storage Capacity in Thousands of Acre-Feet
Sluice Gate and Needle Valve Discharge in Thousands of Second-Feet
Water Surface Elevation above Sea Level, in Feet
Spillway Discharge
Spillway Crest Elevation = 232
Reservoir Storage Capacity
Reservoir Area
Needle Valve Discharge
Sluice Gate Discharge
Invert of Needle Valve Conduit Elevation = 121.25 at End of Transition
Tailwater
Tailwater and Spillway Discharge in Thousands of Second-Feet
Reservoir Area in Hundreds of Acres

FIG. 2. AREA, CAPACITY, AND DISCHARGE CURVES FOR THE MADDEN RESERVOIR

ment of their deflections under repeated loading and unloading. Finally, a test in the field was made by building on bedrock at the dam site a column 5 in. in diameter, on which was balanced a platform 13 ft. square to hold the bags of gravel used as loading. The loading was increased until it reached 7,500 lb. per sq in. on the bedrock without evident failure. At this load the column had settled into the rock to a depth of 0.257 in.

It is interesting to compare this loading of 7,500 lb. per sq. in. with the average compressive strength—1,600 lb. per sq. in.—of specimens in a testing machine. The increase of about 6,000 lb. in the load borne by the specimen in place over that borne in the testing machine was due to the lateral support given by the rock surrounding the bearing area. When the field test was completed, a

block of stone containing the bearing area was taken out and cut across with a saw. The surface was found to be sound, although it was slightly indented by the steel column.

Samples of water taken daily from the Chagres River at Alhajuela were analyzed twice each month to determine roughly the rate of silting. Results indicated that it would require about 350 years to fill the reservoir to elevation 150, and 11,000 years to fill it to elevation 240, which is the normal storage level. There is no need to feel concern over the silting problem.

To determine the rate of leakage and the depth of open jointing, all the core-drill holes on the dam site and many on the ridges were tested with water under pressure. This was done by inserting in the hole to the desired depth a small pipe with an expanding gasket on the end, and pumping in the water. The rate of flow and the pressure were observed and recorded. The depth at which no flow occurred was carefully noted, and was taken as the lower limit of danger from percolation. It is expected that leakage will take place through the thinner ridges surrounding the reservoir, and weirs have been established at strategic points to measure it. Corrective methods will be employed to control any leaks that may be discovered. The depth of the water standing in the various drill holes is recorded weekly, so that any change in the groundwater level due to seepage can be detected by comparing the records taken before and after the filling of the reservoir. This method will aid in detecting porous zones.

Certain parts of the ridges are known to be fissured and to abound in fairly continuous crevices. These are in the limestone stratum and are generally overlain with clay or sandstone. At the crest of the ridges these zones are at fairly high levels and are not a source of great danger; however, they are sufficiently serious to warrant the use of corrective measures without waiting until water has found its way through them.

FISSURES CLOSED WITH THIN CLAY

The work of filling these seams is now in progress. A system of holes has been worked out so as to penetrate the jointed and seamy parts of the ridges at many places. After a hole is drilled, a pipe is cemented part way down so that it will discharge at a predetermined depth. A thin clay is then forced into the hole under a pressure of 100 lb. per sq. in. This mixture fills all openings and finally ceases to flow. Then a thicker mixture is forced in at a pressure of 300 lb. per sq. in. The higher pressure usually causes a renewed flow. Varying quantities of the thicker mixture are required to bring a hole to the point at which it will resist the higher pressure. The holes are so spaced that at no place are they more than 26 ft. apart, since it was learned by experiment that the clay grout would flow half that distance through small crevices.

One very large cavern, known as Sinkhole No. 20, was discovered by mining into an underground drainage channel. Although the sinkhole does not lie in the high part of the ridge, five of its branches lead toward the ridge and are considered to be potential sources of danger. These branches are therefore being filled. First a dam was built across their mouths and then holes—sometimes over 100 ft. deep—were drilled from the surface of the ground to intersect the branches at their highest points. The branches were then filled with puddled clay poured through the holes. When a drill hole is filled with clay it acts like a stand pipe to greatly increase the pressure and cause the clay to close all crevices tightly.

The Madden Reservoir will have a drainage area of 427 square miles and a capacity at normal water level of 22 billion cu. ft. (500,000 acre-ft.). In addition it will have a retention volume of 10 billion cu. ft. for flood control. The spillway will be designed to pass 280,000 sec-ft., the estimated momentary rate of run-off that may occur once in 1,000 years. This is equal to 650 sec-ft. per square mile. At the dam site, the maximum recorded momentary rate of run-off is 177,000 sec-ft., and the average rate is 2,522 sec-ft. The average annual run-off past the dam is 81 billion cu. ft. (1,800,000 acre-ft.). In Fig. 2 are shown the hydraulic characteristics of the reservoir and the capacity of the spillways.

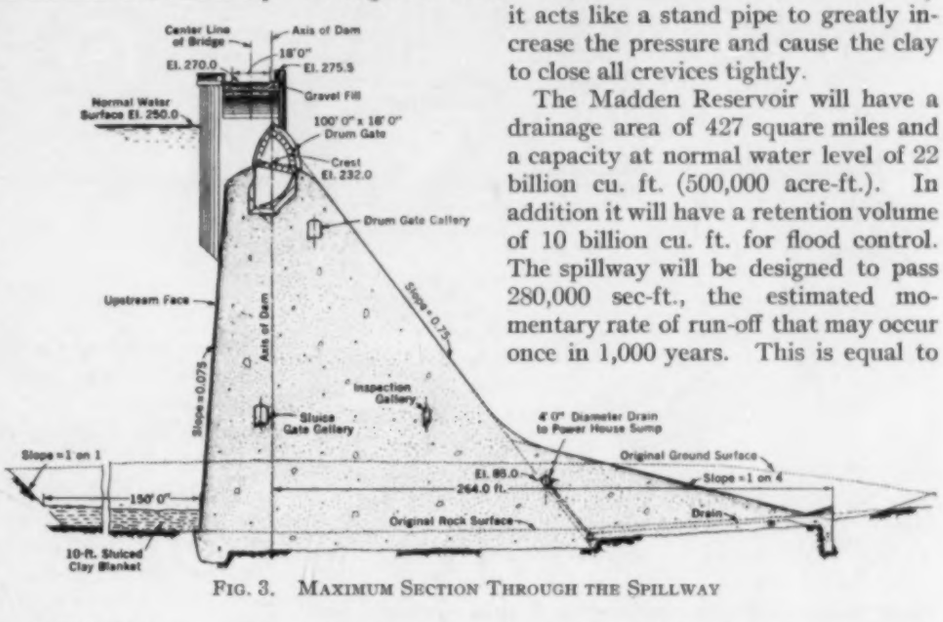


FIG. 3. MAXIMUM SECTION THROUGH THE SPILLWAY

In the Canal Zone the year is divided into two seasons, the dry season, which occupies the first four months of the year, and the wet season, which lasts the other eight months. The annual rainfall varies from 69 in. on the Pacific Coast to 128 in. on the Atlantic Coast. The maximum recorded rainfall per 24 hours at the dam site was $12^1/_4$ in. The mean annual temperature is about 79 deg. fahr.; the maximum is 98 deg. and the minimum is 59 deg. So high is the relative humidity that at times it reaches 100 per cent.

In computing run-off data for the Madden Reservoir, records of river flow dating back to 1879 were used. To determine the characteristics of expected floods, several hydrographs of the larger floods were plotted and from them the rate of rise and fall of the flow was assumed. The maximum momentary rate of flow of the river past the dam was then calculated by "probability" methods. After assuming a rate of rise and fall preceding and following the peak rate, it was possible to derive several probable hydrographs for the so-called "1,000-year flood." After the hydrographs were derived, the imaginary floods were passed into the Madden Reservoir, thence

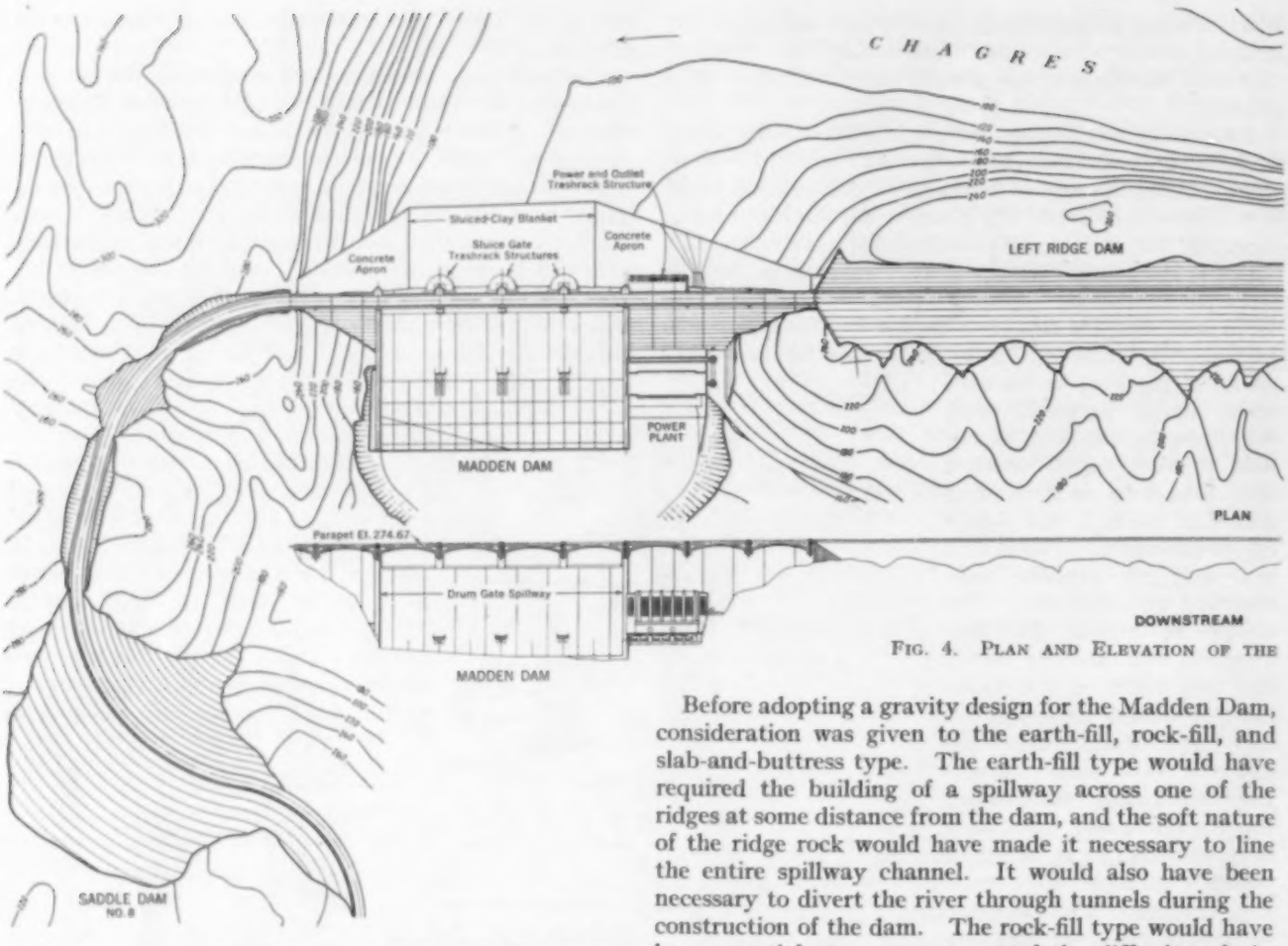


FIG. 4. PLAN AND ELEVATION OF THE

through the Madden spillway and into Gatun Lake, through Gatun spillway, and into the sea. Both the Madden and Gatun spillway gates were assumed to be so regulated as to cause the least possible interference with traffic through the Canal.

A flood may interrupt traffic either by causing a strong flow into the Canal at Gamboa from the River Chagres, or it may cause such high water levels that it will be impossible to operate the locks. The problem of lock operation is very involved and is influenced by surges in Gaillard Cut. The first lock to suffer from a great flood would be Pedro Miguel, because the gage height at Gamboa would directly influence the gage height at Pedro Miguel, whereas Gatun Lake acts to dissipate the flood wave before it arrives at the Gatun Locks. Another cause of interference with lockages in times of flood is the discharge of water from Gatun Lake to the ocean directly through the lock culverts. When this is done no lockages can be made. Such discharge is allowed only when traffic has already been interrupted for other causes.

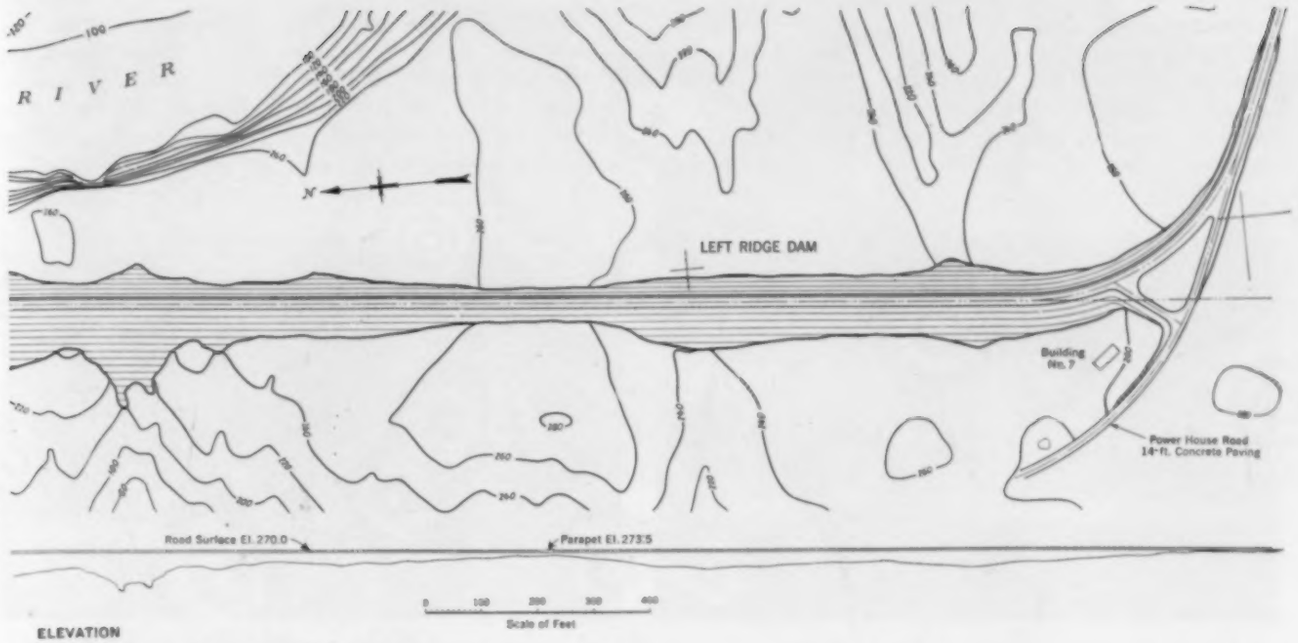
The calculations of the effects of a 1,000-year flood on lockages and lake levels indicate that the maximum high-water level in Madden Lake would be +262.0 ft., and in Gatun Lake, +91.5 ft.; and that the minimum period of interruption to traffic with most favorable gate operation would be 56 hours. It was also determined that none of the floods of record over a 50-year period would have caused any interruption to traffic if the Madden Reservoir had been in operation.

Before adopting a gravity design for the Madden Dam, consideration was given to the earth-fill, rock-fill, and slab-and-buttress type. The earth-fill type would have required the building of a spillway across one of the ridges at some distance from the dam, and the soft nature of the ridge rock would have made it necessary to line the entire spillway channel. It would also have been necessary to divert the river through tunnels during the construction of the dam. The rock-fill type would have been unsatisfactory on account of the difficulty of obtaining a cut-off against seepage under the dam. Any large amount of seepage through the foundations would be very dangerous on account of the presence of soluble limestone. The slab-and-buttress type has the same drawbacks as the rock-fill type in that it depends on a single cut-off wall for protection against seepage. A modified slab-and-buttress dam with a floor was designed, but it proved to be more expensive than the gravity type.

GRAVITY TYPE OF DAM SELECTED

The straight massive concrete gravity type of section shown in Fig. 3 was finally selected. The dam will be about 900 ft. long and 220 ft. high at maximum section and will have a base width of about 180 ft. The downstream slope will be $^3/_4$ on 1, and the upstream, $^3/_4$ on 10. The weight of the dam will be so balanced that at all conditions of water load the unit compressive stress in the upstream parts will be greater than the unit water pressure. This makes it impossible for any tension to occur as a result of uplift. The general plan of the structure and the downstream elevation are shown in Fig. 4.

The designs and specifications for the Madden Dam were prepared by the staff of the Bureau of Reclamation in Denver under R. F. Walter, Chief Engineer, and J. L. Savage, Designing Engineer, Members Am. Soc. C.E., with the collaboration of five engineers from the Panama Canal. Thus the broad experience of the bureau's engineers was made available, and the difficulties and loss



MADDEN DAM ON THE CHAGRES RIVER

of time incident to the development of an adequate force in the Canal Zone were avoided.

The main dam is the spillway, which contains 4 drum-type gates, each 100 ft. long and 18 ft. high. Downsteam from the dam is a heavy concrete apron about 120 ft. long with a sloping sill at the downstream end to create a back roll. The shape of this apron was determined from tests made on models at the hydraulic laboratory of the Colorado Agricultural College at Fort Collins. Upstream from the dam for a maximum distance of 150 ft. there will be a sluiced clay blanket 10 ft. thick to increase the percolation distance beneath the dam and to reduce the chance that the calcareous constituents of the foundation stone will be dissolved and carried away. The foundations will be thoroughly grouted and the usual drains will be eliminated, as it is thought that they might assist in the formation of percolation channels.

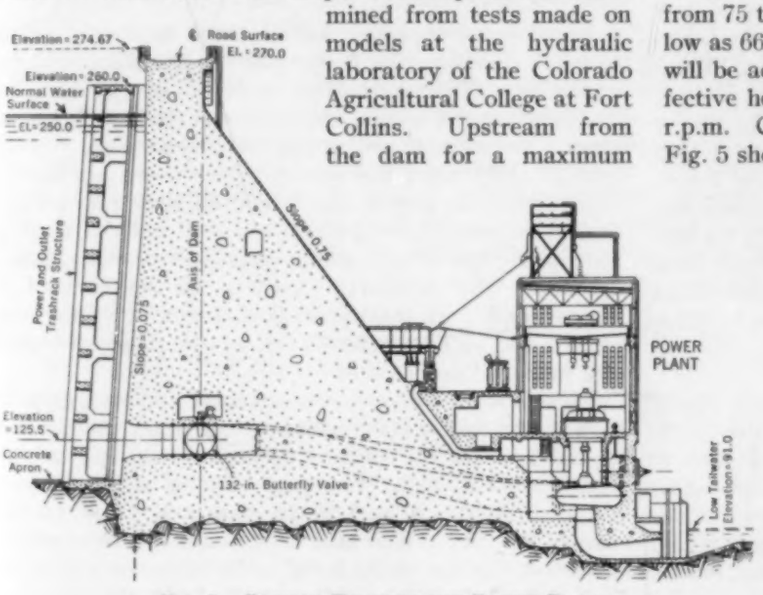


FIG. 5. SECTION THROUGH THE POWER PLANT

Below the dam, on the left bank of the river, there will be a power plant with 3 generators, each of the 3-phase, 25-cycle type with a capacity of 10,000 kva. but only 2 will be installed initially. Each generator will be driven by an 11,200-hp. turbine. Current will be generated at 6,600 volts but will be stepped up to 44,000 volts for transmission. Demands on the water supply for both lockage and power will draw down the reservoir level so that the turbines must operate under heads varying from 75 to 145 ft., and, on rare occasions, under heads as low as 66 ft. and as high as 166 ft. Maximum efficiency will be achieved with an output of 9,000 hp. and an effective head of 120 ft. The normal speed will be 214.2 r.p.m. Cast-steel runners will be used. The section in Fig. 5 shows the arrangement of the turbines and generators in the plant.

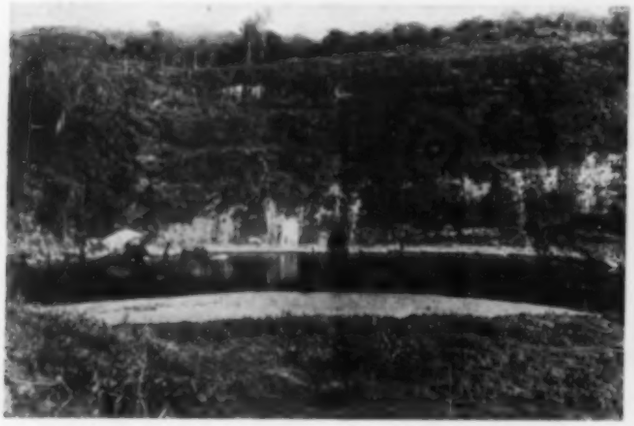
The left wing of the Madden Dam will be formed by a wing dam of earth, gravel, and rock fill, having a concrete face slab 12 in. thick at the bottom and 8 in. thick at the top. It will be 2,700 ft. long, and 20 ft. wide on top, and will have an upstream slope of $1^3/_4$:1, and a downstream slope of $2^1/_2$:1. The downstream slope will be a rock fill, and the body of the dam will be a rolled fill of earth mixed with gravel.

Along the ridge to the east of the main dam there will be 13 saddle dams of various heights up to 54 ft. Two of these, Nos. 5 and 8, are relatively large and will have concrete core walls. All saddle dams will have top widths of 20 ft. except where the highway is on top of the dam. They will have 4 : 1 upstream slopes and $2^1/_2$: 1 downstream slopes, and will be of earth, gravel, and rock fill.

PROVISION MADE AGAINST EARTHQUAKE SHOCK

To insure that the Madden Dam will act as a monolith and will be water-tight, all vertical contraction joints will be provided with grout pipes, and after the setting heat has partly escaped from the concrete these joints will

be grouted under pressure. Because of the soft nature of the foundation stone the value of the sliding factor has been limited to 0.65. The bearing pressures on the foundation will be rather light for a dam of this height; the maximum inclined compression will not exceed $18^1/_2$ tons per sq. ft., including the allowance for earthquake



RIGHT ABUTMENT OF THE MADDEN DAM

LEFT ABUTMENT AND LEFT RIDGE, MADDEN DAM

effect and considering headwater to be at elevation 250 ft. and tailwater at elevation 95 ft.

This region is frequently disturbed by mild earthquake tremors, reports of which date back to 1621. In 1882 a rather severe shock rocked Panama. Seismographic records of the Panama Canal Zone date from 1909. During the 21 years from that date up to the end of 1929 there were 912 quakes recorded. The problem of estimating the water pressure caused by an earthquake was later studied for Madden Dam by the Bureau of Reclamation, and a theoretical analysis was made during February 1930. A similar analysis was made for the Hoover Dam and appears in the PROCEEDINGS of the Society for November 1931. Using an acceleration factor of 0.1*g* for horizontal effect and a period of vibration of 1 sec., the mathematical analysis indicated that when the reservoir is empty, an earthquake causes practically no tension. During an earthquake, with the reservoir level at +250, the maximum value of the sliding factor occurs at the base of the abutment section and amounts to 0.674.

DAM CONSTRUCTED BY CONTRACT

The regular construction force of the Panama Canal is well equipped and organized to meet any of the operation or construction needs of the Canal Zone, but to undertake the specialized work of building a dam across a flowing river would have called for a new branch of our construction organization, with the result that added burdens would have been placed on other Canal offices, causing a temporary congestion at several points.

Under an arrangement by which the Government should furnish all material forming a permanent part of the structure, supervise the installation of machinery and direct the entire work of construction, it appeared that the contract method would have a decided advantage over the force account method.

Between June 15, 1931, when the invitation for bids was issued, and September 1, 1931, when the bids were opened in Washington, the dam site was visited by 17 contracting firms, including four who are contractors for Hoover Dam. Eight bids were received. The low bidders were the W. E. Callahan Construction Company, of St. Louis, and Peterson, Shirley and Gunther, of Omaha, whose joint bid amounted to $4,048,657. The spread from the lowest to the highest bid was nearly two and a quarter million dollars.

In the following tabulation, a few unit prices for the Madden Dam are compared with those for the Hoover and Owyhee dams:

	Madden	Owyhee	Hoover
Date of opening bids	Sept. 1, 1931	June 7, 1928	Mar. 4, 1931
Common excavation in dam, cu. yd.	$1.50	$1.85	$2.20
Rock excavation in dam, cu. yd. .	3.10	4.00	4.40
Concrete, mass, in dam, cu. yd. .	2.50	3.50	2.70
Placing reinforcing bars, per lb. .	0.009	0.015	0.0075
Installing spillway gates, per lb. .	0.0225	0.02	0.02

Diversion of the river will be made across the point to be occupied by the power plant. A channel 110 ft. wide with bottom at elevation + 94 will be cut through, and part of it will become the tailrace of the hydro-electric plant. Between the diversion channel and the river a cellular sheet-pile cofferdam will be thrown across the river above the site of the dam. To form part of the barrier between the diversion channel and the river a narrow section of the dam proper will be constructed initially. The estimated capacity of the channel is 65,000 sec-ft. In case larger flows occur, the cofferdam section will be flooded and work will be suspended until the water is pumped out.

As soon as the diversion channel is completed, excavation will be started for the foundations of the central part of the dam, for the spillway apron downstream, and for the sluiced clay blanket upstream. This work will cover an area 480 ft. up- and downstream and 380 ft. on the axis of the dam. The base of the dam will be about 40 ft. below the low-water level. After this section of the dam is built to a point above river level, the diversion channel will be dammed off and the water will flow through the ground sluices in the main dam and over the lower sections of the dam itself.

The power plant structure and the dam will be built up simultaneously, and during this construction the water will be diverted over the spillway section until the head is sufficient to force it through the ground sluices. It is expected that the final course, which includes the spillway gates, will be built during the dry season of the last year of construction, probably 1935.

UNIT OF NEW STORM-DISCHARGE SYSTEM

Exterior of Station No. 1. Three 14-Ft. Screw Pumps, with Capacity of 1,000 Sec-Ft., on Right. Discharge Canal to Pumping Station No. 6 in Foreground

Rainfall at New Orleans and Its Removal

Solving an Acute Drainage and Sanitation Problem

By GEORGE G. EARL

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

EARL ENGINEERING COMPANY, NEW ORLEANS

PERHAPS no city in the world—certainly no city in this country—has such peculiar drainage conditions as New Orleans. The major part of the population resides within an area of 44 square miles (or 28,000 acres), about half of which is closely built up and over the other half of which population is now spreading. Of this area about one-third is at or below mean sea level, which is also the mean level of Lake Pontchartrain, bounding the city on the north; another one-third is above this but at or below high (or storm) tide level in the lake; and the remaining one-third, although above the highest lake level, is still from 8 to 16 ft. below high-water level in the Mississippi River, which bounds it on the south.

There is therefore no natural low-level outlet for the escape of storm water or sewage. Instead, every drop that falls as rain, or is brought into the city for water supply, must either evaporate or be removed by pumping. It goes through from one to four successive lifts before it is finally discharged into tide-level outlets, or into force mains leading into the Mississippi River.

Storm water is discharged into leveed tidal outfall canals against heads ranging from 5 to 9 ft. for intermediate lifts and from 10 to 14 ft. for the final lift. For final discharge into the Mississippi River, the sewage and contaminated dry-weather flow are raised from 40 to 100 ft., including the friction losses in the force mains.

Under such conditions, the rate of discharge becomes very important as it affects the design of the collection drains, sewers, outlets, and power and pumping capacity to be provided. Of equal importance are the factors of frequency and duration of the various rates of continuous rainfall.

We all seem to lack "rate consciousness" in matters of precipitation and run-off. Rainfall records as complete as those for New Orleans should be of special interest since they culminate in five years of unprecedented frequency and intensity for "great rainfalls." This term is taken rather arbitrarily to mean consecutive rainfalls of 5 in. or more in 5 hours, or 7 in. or more in 24 hours, as shown on at least one of the six recording rain gages that have been maintained by the city since 1894.

Records are available as given in Table I. They will be referred to by "year periods," as designated.

WATER is often either too plentiful or too scarce. New Orleans' complaint is that it has too much. The Mississippi strains at its levees, threatening the city. But no levees can keep out rainfall, torrential in character. As much as 10 in. has fallen in 5 consecutive hours, and an amount of 14 in. in 19 hours has been experienced. Strangely enough, as Mr. Earl relates, all previous precipitation records have been exceeded during the past 5 years. What this problem involves for the city and the tremendous pumping capacity required to discharge the accumulation of water in a reasonable time are graphically described. Mr. Earl's paper was presented before the New Orleans meeting of the American Association for the Advancement of Science, last December.

RECORDS OF STORMS

In Fig. 1, lines marked "5 years," "31 years," etc., refer to these periods or combinations of them chronologically. To find the maximum consecutive rainfall for given time periods, it was necessary to start with the most intense precipitation and plot the records both forward and backward. All storms of one

inch or more are tabulated in this way in the Sewerage and Water Board records for each year. As will be noted, total hourly records are plotted as far as the 5-hour period, and then the graphs are shown as straight to the end of the record periods.

In general, these curves of record precipitation are

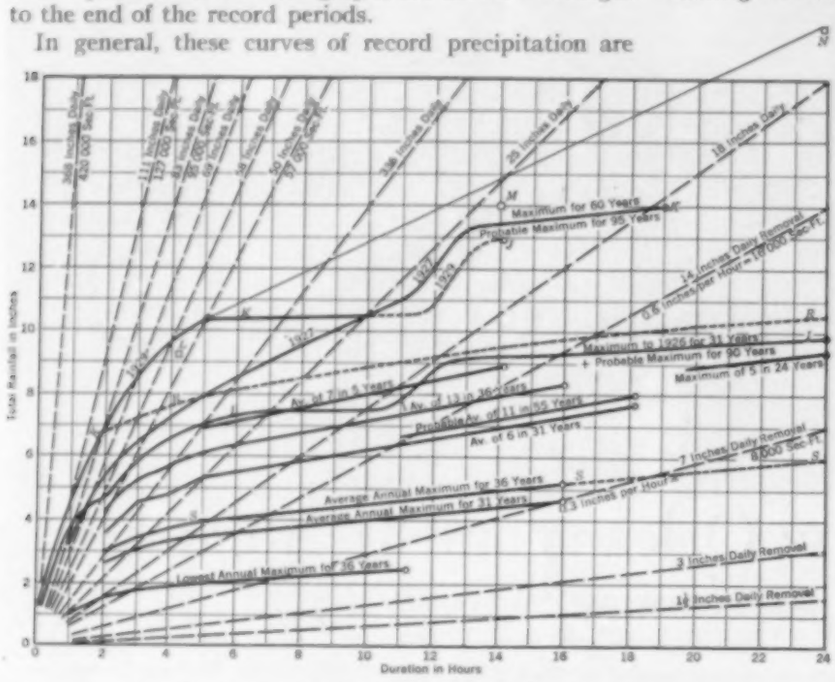

Total Rainfall in Inches
Duration in Hours
Maximum for 60 Years
Probable Maximum for 95 Years
Maximum to 1926 for 31 Years
+ Probable Maximum for 90 Years
Maximum of 5 in 24 Years
Average Annual Maximum for 36 Years
Average Annual Maximum for 31 Years
Lowest Annual Maximum for 36 Years
14 Inches Daily Removal
7 Inches Daily Removal
3 Inches Daily Removal
1½ Inches Daily Removal
0.6 Inches per Hour = 1,000 Sec. Ft.
0.3 Inches per Hour = 500 Sec. Ft.
18 Inches Daily
20 Inches Daily
1927
1929

FIG. 1. RECORD STORMS FOR THE NEW ORLEANS DISTRICT
Relation Between Precipitation and Duration of Storms, with Comparable Removal Rates

approximately parallel. The line marked *I–I* on Fig. 1 is irregular in character, inasmuch as it represents the maximum of all storms since 1895 recorded on any Sewerage and Water Board gage before 1926. I have not been able to find any evidence of a greater maximum at New Orleans prior to 1895.

EXTREME PRECIPITATION

In a very able paper on the frequency of various rates of rainfall, Merrill M. Bernard, M. Am. Soc. C.E., in PROCEEDINGS for October 1930, proposed a formula and constants for various localities which seemed to indicate the line *RR*, Fig. 1, as the probable "once-in-100 year" rainfall for this locality, with the line *SS* as the "once-in-5-year" rainfall. As will be noted, this latter line seemed to fit fairly well with the maximum records of the Sewerage and Water Board prior to 1926, assuming that nothing since 1836 had exceeded these records; but with the two great storms of 1927 and 1929 added, the previous records were greatly exceeded. These facts are shown on the records plotted in Fig. 1. With the maximum record rainfall now standing at the line *KK*, it appears that the line *RR* is badly out of place.

TABLE I. EXTENT OF RAINFALL DATA FOR NEW ORLEANS

PERIOD	DURATION	SOURCE	REMARKS
35 years	1836 to 1870 incl.	U.S. Weather Bureau	10 years missing
24 years	1871 to 1894 incl.	U.S. Weather Bureau	Complete for 1 gage
31 years	1895 to 1925 incl.	Sewerage and Water Board	Complete for 6 gages
5 years	1926 to 1930 incl.	Sewerage and Water Board	Complete for 6 gages

A few scattered records are also shown. For example, point *L* (about 9 in. in 4 hours in 1891) is from a U.S. Weather Bureau report from Luling, La., about 20 miles west of New Orleans. When the drainage system was designed in 1895, this report was the only bit of evidence from anywhere in this locality indicating such excessive intensities for so long a duration. There was nothing remotely resembling it at New Orleans at that date. Point *M* was reported by the press several years ago from Miami, Fla. Point *N* was reported from the Jefferson (Plaquemine Drainage) Pumping Station, 9 miles south of New Orleans, in the 1927 storm. This storm covered a very wide area. Since it was reported at several points as being much greater than the 14 in. recorded at New Orleans and as the reports from the Jefferson station were usually reliable, it seems that the possibility of 20 in. of rainfall in 24 hours as well as of 10.38 in. in 5 hours, or 4.63 in. in one hour, cannot be ignored.

INTERESTING CONTRASTS

A comparison of the storms for the 31-, 24-, and 5-year periods shows that the frequency of storms of 5 in. or more in 5 hours, or 7 in. or more in 24 hours for the 5-year period was 7 times greater than for the preceding 55-year period and over 7 times greater than for the previous 31-year period. The average intensity for the whole duration of these 7 storms in the 5-year period was 57 per cent greater than that of the 6 storms in the prior 31-year period; and for durations of from 1 to 5 hours, it was 34 per cent greater.

In intensity the maximum of the 5-year period exceeded the maximum of the preceding 31-year period by 80 per cent for the whole duration of the storms; and by from 47 to 63 per cent for various equal time periods of from 1 to 15 hours. Comparing the same records, it is found that the average annual excess of rainfall above 5 in. in 5 hours was 26 times greater for the 5-year period and that the frequency of any such excess was over 10 times greater.

If the comparison is confined to storms which equaled or exceeded 7 in. in 5 hours, there is one of 7.02 in. in 1903 as compared, successively, with storms of 7.45, 7.88, and 10.38 in. in 1926, 1927, and 1929, respectively. That is, in 1929 there was 18 times the frequency with 6 per cent, 22 per cent, and 47 per cent greater intensity for the 5-hour duration, with an average of over 40 per cent more total rainfall and an average intensity for its duration 75 per cent greater. The records for these 4 storms of 7 in. or more in 5 hours are quite remarkable considering the fact that no other storm of as much as 6 in. had been recorded since 1894, and that only 7 other storms of between 5 and 6 in. in 5 hours had been recorded, 3 in the 31-year period and 4 in the 5-year period.

PUMPING REQUIRED

This breaking of records seems almost unbelievable, but it is corroborated by other data. Drainage pumping station No. 6, serving 11,000 acres of the uptown area of New Orleans, where the greatest rainfall intensities were

recorded, had to operate to its full capacity 28 times longer per average month after 1926 than had been necessary before. This is the best possible confirmation, and probably also the best possible measure, of the relative rainfall intensities as influencing drainage difficulties.

On Fig. 1 the graphs of the various rainfalls have been plotted with their period of maximum intensity first. For comparison, starting from the same point of origin, various removal rates by pumping are shown expressed in inches of rainfall per 24 hours. If great storms always occurred in the same way, with their periods of greatest

CONSTRUCTION OF CONCRETE CANAL NEARING STATION NO. 6
Piles Both Support and Hold Down the Lining

intensity first, the full removal capacity would be effective from their inception, and soil absorption would also operate for the reduction of the accumulated water during the maximum downpour. Then when a given pumping capacity, as shown graphically, approaches within, say, 2 in. of the rainfall curve, all the water quickly removable from the surface would have been disposed of.

If, on the other hand, the soil is already fully saturated and the system already filled when the period of greatest intensity of rainfall occurs, substantially all the subsequent rainfall is removable water and the graph's removal rate must intersect the rainfall line before disposal is completed. Prior to 1900 the pumping rate was equal to about $1^1/_2$ in. of rainfall per day over the area drained. The new drainage system completed in 1916 had a removal rate of 3 in., increased in 1930 to 7 in. After 1932 it will be equal to 14 in. of rainfall in 24 hours. These rates are shown on Fig. 1.

Since 1916, the largest and most efficient low-lift pumps ever built, the largest low-lift pumping stations, and the greatest sum total of low-lift pumping capacity anywhere, have been in operation in New Orleans. In the present doubling of both the intermediate lift and the final discharge capacities of the six great drainage pumping stations, still larger low-lift screw pumps are being used. Sixteen of these units, 14 ft. in diameter and of a capacity of 1,000 sec-ft., have been installed. All these electrically driven pumps are served by a city power station of 27,000-kw. capacity and connected with it by both underground and overhead transmission lines on a looped system. Every reasonable precaution is taken to prevent any failure in the supply of current. The accompanying photographs illustrate the recent additions of pumping stations Nos. 1 and 6 and the

DRAINAGE STATION NO. 6, INTAKE SIDE, SHOWING SCREENS 250 FT. LONG
Building Contains Four Pumps of 1,000 Sec-Ft. Capacity (1920–1930); Two of 750 Sec-Ft. (1915); and Four of 250 Sec-Ft. (1900)

connecting canal. These are the largest extensions of the new systems.

AN EXTENSIVE REMOVAL SYSTEM

This system, with its provision for removing 14 in. of rainfall per day, has cost roughly $1,400,000 per in. of capacity. When all the necessary canals are completed, including masonry lining, the whole will have cost at least $2,000,000 per in. Even assuming the most extreme frequency and intensity of "great storms" recorded since 1925, it is not likely that this full capacity can be used oftener than once in two or three years or, on the average, for more than two or three hours a year.

Even for a rainfall of 14 in. in 19 hours, falling at a fairly uniform rate, and allowing 2 in. for soil absorption and storage, there would not be more than an inch of removable water on the surface at the end of the storm. Such a severe storm would mean the concentration of a quarter of an average year's rainfall in a 19-hour period and its removal or absorption within a 21-hour period.

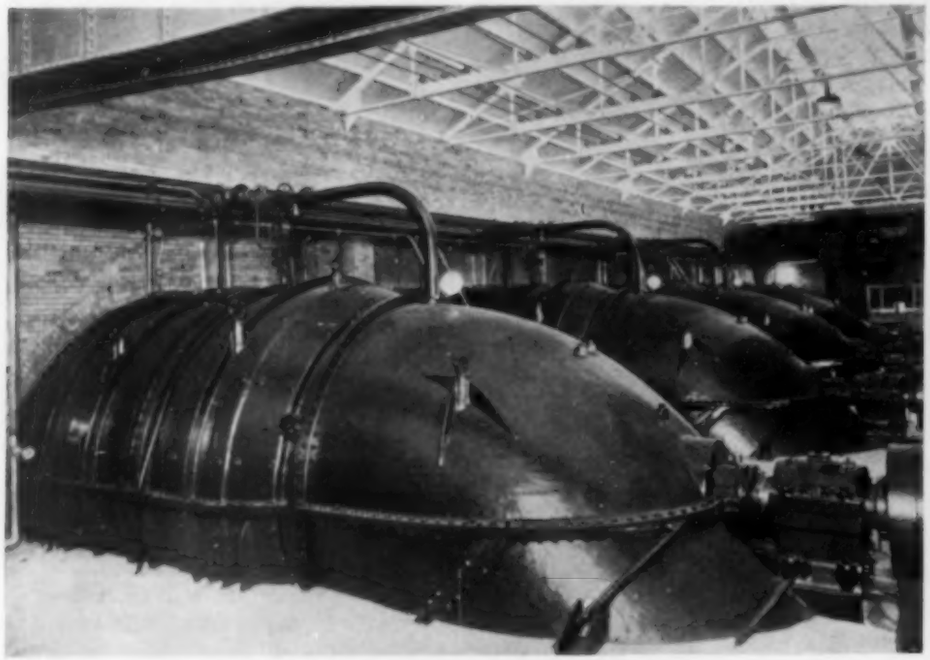
EFFECTS OF IRREGULAR RAINFALL

This much the public usually can understand. What they cannot seem to realize, however, is that if this same 14 in. of rain in 19 hours happened to fall first as 6 in. fairly distributed over a period of 11 hours, and then concentrated as 8 in. in the last 5 hours, it would have disastrous results. Of the last 8 in., only 3 in. can be removed, and 5 in. must remain somewhere on the surface at the end of the storm. The present doubling of removal capacity has only decreased the surface water remaining from the equivalent of $6^1/_2$ to 5 in. of rainfall.

The advantage of the increased capacity lies mainly in the fact that the system can remove this remainder twice as rapidly, and that, for shorter but very intense storms, an adequate pumping system can maintain full capacity delivery through the drains and prevent any greater accumulation of water in the low area. The two unprecedented storms of April 1927 and September 1929 both terminated thus.

A removal capacity of 28 in. per day for some parts of the uptown area (or double that now being provided)

during the 5 hours of greatest rainfall intensity would still have lagged by more than 4 in. at the end of the September 1929 storm and by about 2 in. all over the city at the end of the April 1927 storm. It would be utter folly to expend the many millions of dollars required to give any greater removal capacity than is now being provided. There is no danger; and if people build with reasonable foresight, understanding the possibility of occasional rainfalls of excessive intensity and duration, no damage and little inconvenience will arise from small accumulations of water which are very quickly removed.



BATTERY OF LARGE PUMPS, STATION NO. 6
FOUR 14-FT. MOTOR-DRIVEN UNITS, EACH WITH A CAPACITY OF 1,000 SEC-FT. AGAINST A 14-FT. LIFT

POPULAR MISCONCEPTIONS

The average citizen's grasp, or lack of grasp, of engineering facts is grotesque. Concerning innumerable sporting and other events, the papers publish, and the public understands, all the essential data; and vast mechanisms, both mechanical and human, are devoted to the prompt dissemination of this information.

A statement that a well known race horse ran an acre in $67^1/_5$ minutes; or that he ran a mile; or even that he ran a mile in $67^1/_5$ minutes would only excite ridicule. But statements no less absurd are constantly made with regard to the performances of Jupiter Pluvius, and very few people even notice their inadequacy.

We are told of a "run-off of 7,000 sq. ft. per min.," or of a "6-in. rainfall," with nothing to indicate whether this amount fell in one hour or one month. Or the flooding of a city to some stated depth is reported when only a very small part of it was flooded to a maximum depth above curb level of half the stated depth.

RAINFALL CARRIES GREATEST STAKES

As a matter of fact, the races run by the "rate of rainfall" against its own past records and against such hurdles as man or Nature can provide carry the greatest stakes and constitute one of the most important factors in the life of the world. Starvation or plenty, prosperity or adversity, and often life or death, are at issue. Crops, lake levels, and river navigation; water supply and public safety; innumerable questions of civic welfare and convenience; and engineering characteristics of the works which should be provided to remove, conserve, or utilize run-off—all of these depend upon the rates, durations, and frequencies of rainfall, which vary in almost infinite degree in different localities, under different conditions, and through different time cycles.

Both for the use of engineers and to arouse general public interest and intelligent understanding of the meaning and importance of rainfall rates, we need many more records, both of rainfall and run-off, than we have at present. We need to be able to give out complete information regarding these events immediately after they occur and before public interest in them has subsided. The necessity of waiting until charts can be removed from recording instruments, or written records assembled and their results counted or calculated, combined or compared, to arrive at rainfall or run-off rates and totals, makes the process too slow. In fact, it is so cumbersome that usually it is not even attempted.

When properly attended to, the type of rainfall recorder in general use gives excellent records. Similarly, the records of the U.S. Weather Bureau are splendid and

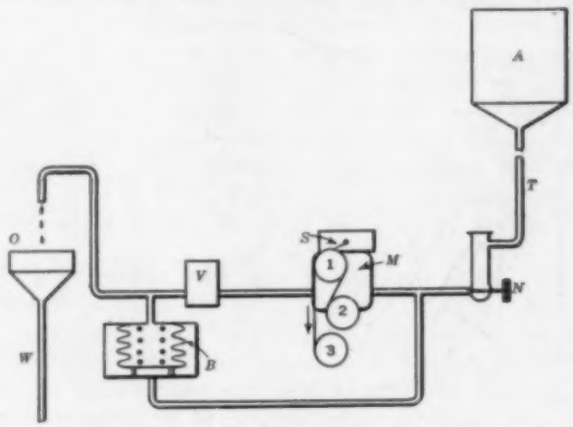


FIG. 2. DIAGRAMMATIC SKETCH OF NEW-TYPE RAINFALL RECORDER

A, Catchment Vessel; *T*, Tube Conducting Rainfall to Recorder; *N*, Needle Valve to Regulate Flow to Keep Tube *T* Full; *M*, Meter with Ordinary Integrating Mechanism; *S*, Stylus Operated by Meter; 1, 2 and 3, Clock-Driven Tape Drums; *B*, Metal Bellows Reservoir; *V*, Gulper Valve; *O*, Outlet; and *W*, Waste

of the utmost usefulness when finally compiled and interpreted by the bureau. Many more records, however, more promptly accessible as to details, would arouse a wider public interest and be of inestimable value in many ways. To attain such records from widely scattered points without skilled attendants in charge, a much simpler form of recorder and a chart that is more easily read are desirable. The existing form of recorder is too difficult for unskilled supervision and too frequently fails to give a satisfactory record.

For some time I have been interested in the development of a form of meter that has practically no limitation with respect to the range of rates which it can correctly integrate and record. The apparatus consists of an ordinary $^5/_8$-in. water meter connected with a combination of valve and reservoir which divides any rate of flow below $^3/_4$ gal. per min. into gulps of flow, which in turn are accurately integrated and recorded by the meter even though they may be 0.01 gal. or less and may be separated by several minutes or hours of time. An attached recording device makes an M-shaped mark on a clock-driven tape on which each stroke, whether it is completed in 5 minutes or 5 days, is countable; it may mean 1 in. of rainfall or 100 gal. of flow through the meter, each gallon of which may be made a proportional flow, in any desired constant ratio, to the discharge of one or of several large or small pumps or full pipe lines. A diagram of the meter is shown in Fig. 2, and a typical record strip in Fig. 3.

In all cases the record is countable and the flow is integrated by the meter. The slope of the stylus stroke indicates the rate of flow. With an 8-day clock, a 31-day chart roll, and a stylus instead of a pen, such an outfit requires very little attention. It needs no electrical connection, and by inspection of the chart will give any information desired as to rainfall or any other flow, large or small, for any interval of past time.

EXTENDING RAINFALL DATA

With more rainfall recorders, more easily maintained, read, and compared, we would get a far better idea than we now have as to the movement of storms and the variations of the rates and amounts of rainfall. There is good reason to believe that the storm of April 1927 was fairly uniform all over the city at 14 in., but Sewerage and Water Board recorders generally ceased to function during the period of its greatest intensity. If there really was a 20-in. rainfall at this time at the Jefferson Plaquemine Pumping Station, as reported by stick measurement, a real record as to just how it fell would be of very great value, especially if we also had equally good records at many other points in and around the city. There are instances in which the concentration of rainfall on the surface in certain areas, where no rainfall recorder was located, was far greater than was warranted by the amount of rainfall recorded in surrounding areas.

GENERAL INTERIOR VIEW OF STATION NO. 6, SERVING 11,000 ACRES OF UPTOWN NEW ORLEANS
Suction Is 7 Ft. Below Mean Tide and Discharge as Much as 7 Ft. Above

The form of recorder suggested could be placed in any house, maintained in reliable operation by anyone who can wind a clock, and reported by telephone to any desired central point by anyone who can count strokes and tenths of strokes in open and clear formation between time lines on the tape chart. Such a report might read as follows: "Rain started 3:30 p.m.; now 5:00 p.m.; total rainfall 2.8 in., of which 2 in. fell between 4:00 and 4:45 and 0.3 in. in last 15 minutes of meter reading; total rainfall to 5:00 p.m., 47.89." The rainfall passing such a meter can be caught and checked by stick measurement if desired, but this is not necessary.

There is nothing dependable about New Orleans rainfalls. They range from 31 to 85 in. per year, with an average of 57 in. The average per month ranges from 3.51 for October to 6.60 for July, but any month may

FIG. 3. SAMPLE RECORD STRIP FROM THE RAINFALL METER
Rainfall from 6:45 to 7:00 Equals 5.4 In. Each Complete Pen Stroke, Up or Down, Indicates 1 In. of Rain; and Slope of Line Shows Rainfall Rate

show more than 8 in. and any, except November and January, more than 13 in. These rates are based on U.S. Weather Bureau records. On the other hand, Sewerage and Water Board records show that the minimum month ranges from 0 in October to 2.29 in. in August, with eight months below a 1-in. minimum and all except August below a 2-in. minimum.

SANITARY SYSTEMS EXPANDED

New Orleans started in 1894 to design and build its main drainage system, and in 1900 to design and build its sewerage and water systems. By 1909 the whole well populated portion of the city was served both by sewers and by the new purified water supply. Thereafter these systems came into general use very rapidly, eliminating vaults and cesspools, preventing foul wastes from being discharged into open gutters, effectively underdraining the soil, and doing away with standing water on the surface. These improvements also did away with mosquito breeding and above-ground cypress cisterns for the storage of rain water, upon which the city had depended almost exclusively for its water supply. They provided an abundant and safe water supply, at very low meter rates, under ample pressure for effective fire protection. The construction expenditures for these great sanitary systems to date have aggregated about $58,000,000, or $125 per capita of present population.

Their present annual cost amounts to about $10.50 per capita, of which one-fourth is paid in water rates and three-fourths in a tax on all the assessed values of the city. From this tax about $3.75 per capita goes to interest and retirement on $27,000,000 of bonds outstanding against the three systems and the remainder to their upkeep and debt-free improvement and extension. This is not a large price for the essential part which these systems have played in the transformation of the unspeakable sanitary conditions which existed in New Orleans prior to 1900, to the present condition, especially when it is remembered what extreme difficulties had to be overcome.

For the decade ending with 1899 the city had an average total death rate of 27.2 per 1,000, with a rate of 104 and 39 per 100,000 due to malaria and typhoid, respectively. It lived in perpetual dread of the introduction of yellow fever, which would bring ruinous epidemic and quarantine conditions.

BENEFITS JUSTIFY OUTLAY

Coincidental with, and in very large measure as a result of, the construction and use of the three great sanitary systems, there has been a constant decline in death rates. There is no further fear of a yellow fever epidemic. The total death rate for 1930 was 36 per cent below that before 1900, and the malaria and typhoid death rates were reduced by more than 98 and 80 per cent, respectively. Applied to the present population, this means 4,600 fewer deaths per year than would have resulted prior to 1900, or a reduction from nearly 35 to about 22 in the average number of deaths that occur somewhere in the city every day.

Added to this we have, because of these systems, infinitely more satisfactory living conditions, making for comfort, convenience, and efficiency. In addition, these systems have saved in many ways much more than their cost, and have gained for New Orleans a general public confidence in its sanitary safety. This is an essential if the city is to prosper and to render its greatest possible service as the gateway to the sea for the waterborne commerce of half a continent.

METARIE RELIEF CANAL CONNECTING STATIONS NOS. 1 AND 6
Canal Is Concrete-Lined. Station No. 6 in Distance

TYPES OF IRRIGATION STRUCTURES ON THE MEDINA PROJECT
Combination Head-Gates, Drops, Checks, and Service Gates, Built of Concrete or Local Stone

The Subdivision of Irrigated Land

How Adoption of the "Natural Plan" Saves in Construction, Maintenance, and Operation

By P. A. WELTY
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FARMERS on the prairies of Iowa and Kansas, accustomed to mile-long corn rows, depend upon rains for irrigation. In the more arid states farther west, the fertility of the soil cannot be brought out without the artificial application of water. Where water is distributed by gravity from an open ditch, the problem is made unduly difficult and expensive if the ditches and turnout gates are located so that one service gate is insufficient to serve the land, or if the farm unit is cut into two or more parts by drainways. A comparison of the costs of construction of canals, bridges, turnout gates, drains, and siphons for two subdivision plans will show substantial savings in favor of the one made to conform with the topography of the land. Except where the ground is flat and the slope is less than 10 ft. per mile, Mr. Welty believes that there is no justification for the rectangular method of subdivision of irrigated land.

DAMS and other large structures of a spectacular nature receive a great deal of the thought, time, and attention of experts, and justly so, as life and property depend on them. But it should not be forgotten that the plan of subdivision of irrigated land may greatly affect the cost of construction, maintenance, and operation of the system as a whole and, in turn, the development and operation costs of the individual farmer and living conditions on the individual farm. Although land subdivision on an irrigation project may have a permanent effect on the success of the project by making possible the saving of large sums of money, too little attention has been paid to this factor in dividing up new sections. Land subdivision is frequently, and rightly, called "land butchering," and the surveyor who does such work is termed a "land butcher."

Economy in surveying is the sole argument for the usual rectangular, checkerboard method, which is the only one that will give "mass production" results. The troubles that follow subdivision of this type are as persistent, as costly to correct, and as difficult to remedy as are the problems of mass production in some of our modern factories.

Farms should vary in size according to the crops grown,

DROP STRUCTURE BUILT OF REDWOOD

TIMBER CHECK IN FARMER'S HEAD-DITCH

the location, the climate, the financial backing of the farmer, the transportation facilities, and the location of markets. The shape of the farm tract should be determined to give the greatest economy in construction and operation. Probably the most efficient shape for a farm would be a circular one, with the buildings in the center; yet there are obvious reasons why a land-selling company would not want to subdivide in this way. Some communities have been planned on this principle, with special treatment of the outlying areas, which were turned into parks and "commons" for pastures.

The sectionalization of our country, and much of Canada, was adopted because it was the simplest and cheapest thing to do. It was particularly ill adapted to rough country and has required much revision to provide for roads and rights-of-way as development has spread over the land. Much of this subdivision work was let out by contract; some of it was well done, but some was done very crudely. The attempt to put roads along section lines caused the first adverse criticism of this method, because their arbitrary location often required excessive grades, numerous drainage culverts, and frequent and costly bridges for creek crossings.

Where subdivision is complicated by irrigation, the problem becomes more complex. Much study should be given the plan to save initial construction costs and perpetual operation and maintenance charges. Every farm must have roads for ingress and egress; a drainage outlet—an absolute essential; and canals or laterals that will reach the high side or corner of every farm unit. One service gate is absolutely necessary, but more than one is an expense and probably also a nuisance, especially if the additional gates are from different canals or laterals. If it happens that a single farmer must be served by more than one ditch rider, as might occur where a farm is split by a creek, then there is twice the cause for argument and trouble. Every gate is a probable cause of friction. Many of the difficulties of operating an irrigation project are not in connection with the mechanical or physical service of water, but with the human elements that enter into the problem.

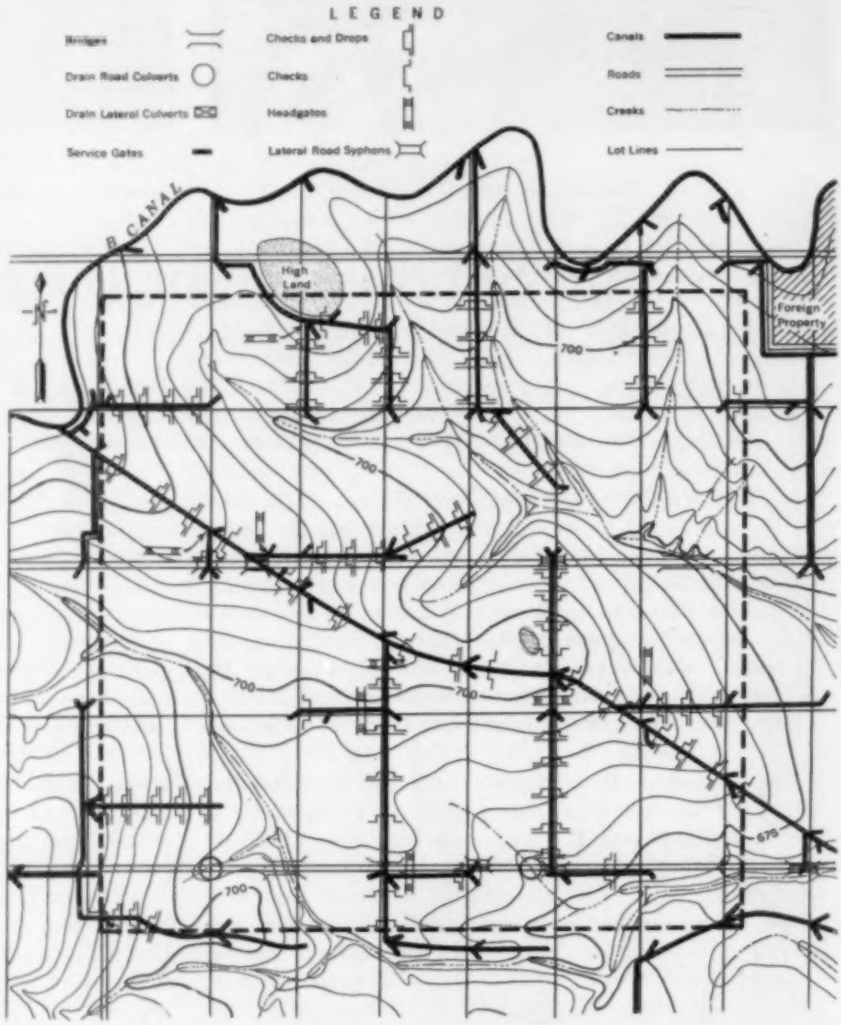


FIG. 1. A TYPICAL SQUARE MILE OF IRRIGATED LAND Subdivided According to the Usual Arbitrary Plan

MANY FACTORS INVOLVED

For every gate set there must be considered such items as the following: (1) first cost, varying from that of a simple timber gate to that of one constructed of cast iron, pipe, and concrete; (2) maintenance costs; (3) replacement cost, if the gate is of inferior type; (4) probable weakening effect on the canal levee; (5) probable requirement of a check structure in the canal that will raise the water level sufficiently to guarantee satisfactory water delivery; (6) eventual expense of a meter or other measuring device; (7) supervision by a ditch rider; (8) clerical work and records of the ditch rider; and (9) additional work in the irrigation office upon application for water.

The problem of constructing and maintaining crossings of valleys, swales, and depressions by the service laterals of the canal system and the head-ditches of the farmer, is one of the most troublesome on a project, and one which such a plan as that recommended would obviate. These two constructed features cross the natural drainage channels of the country at right angles. In the case of the service laterals, there may, or may not, be money enough to construct them properly. As for the head-ditches or other small structures that must be built by the farmer, they are usually constructed crudely and inadequately because of the limited means at his disposal, with the result that washouts and "breaks" continually occur, causing damage and more expense.

To illustrate the advantages that may accrue to a property that is subdivided according to an irregular, natural, landscaped plan, a typical square mile of the Medina

Irrigation Project in Texas has been selected for comparison. The Medina Project consists of about 45,000 acres of rolling land from 20 to 35 miles southwest of San Antonio, and is served by gravity from a storage reservoir on the Medina River. A part of the irrigation project was originally subdivided according to the conventional rectangular system, absolutely without regard to canals, roads, drainage ways, or topography. More recently other parts of the project have been subdivided by the more natural plan that takes topography into consideration.

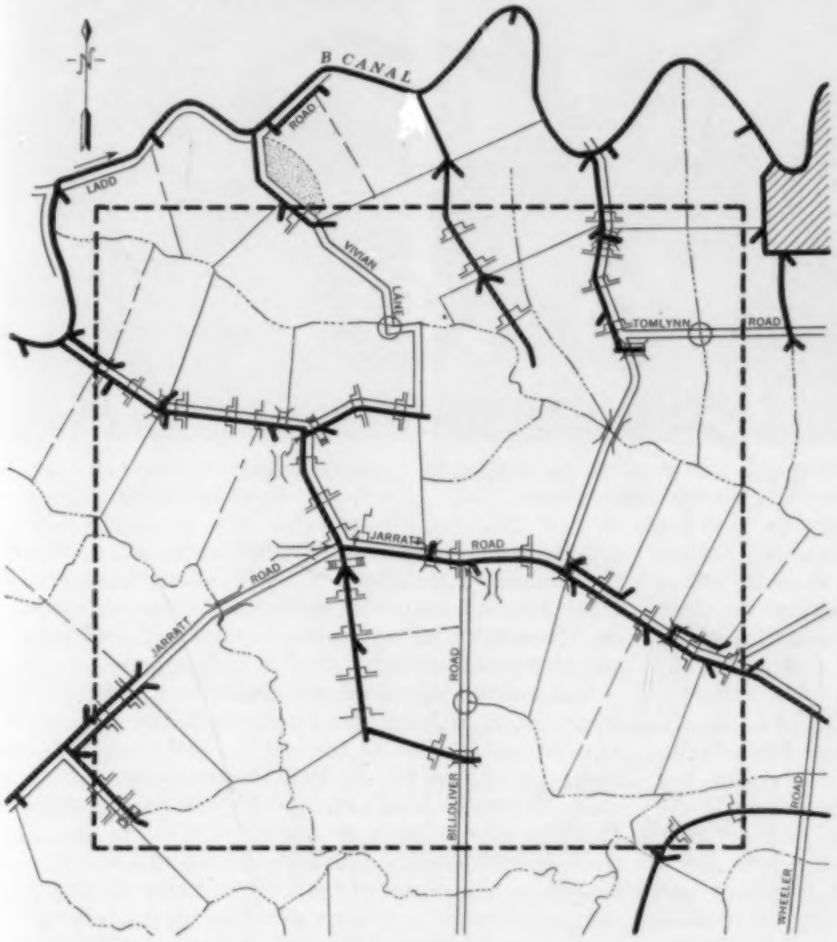


FIG. 2. THE SAME AREA SUBDIVIDED ACCORDING TO THE TOPOGRAPHY
An Irregular, Landscaped Plan Saves Construction and Operating Costs

The typical square mile is a part of a 5,000-acre tract near Lytle, Tex. In Fig. 1 it is shown divided on the rectangular plan with a canal and lateral system projected to serve the lots shown. This is part of the plan that was used as the basis of an estimate of the project to determine the amount of the bond issue. Had this method been followed, no doubt some changes would have been discovered in the field during construction and these would have altered the plan slightly.

In Fig. 2 the same area is shown, with contours omitted, as it was subdivided to fit the topography. The ground was actually laid out and sold according to this plan. Roads, canals, laterals, and services are indicated as they were constructed. According to each method the tract is subdivided into farm units of approximately 20 acres each. In Table I is given a comparison of the number of structures of various kinds that were required by the two methods of subdivision, except farm bridges inside the farm unit.

In Table II are given in detail the quantities and costs of development of the whole 5,000-acre tract from which the typical square mile was selected. It shows in an even more startling way not only the saving in construction costs but also that in canal area and road right-of-way.

About 60 per cent of the saving of 219 acres that results from the use of the plan shown in Fig. 2 is accounted for by rights-of-way reserved for canals, as less canal mileage is required by this plan. The remainder of the saving is due to the fact that the canal around the hill marked "high land" was located at a higher elevation than is indicated in Fig. 1. Although rights-of-way are furnished by the land-holding company and cost the district nothing, every acre saved from use as a right-of-way can be sold and is therefore an asset.

The comparison in Table II shows a net saving of over $56,000, or $13.72 per acre. To this should be added the saving from 115 acres of right-of-way valued at $200 per acre. The gross total saving resulting from a natural subdivision plan then is $79,490, or approximately $18.50 per acre.

The cost of the actual surveying for the natural plan will be more than that for the rectangular, regular, coordinate plan, especially in the meander survey of the swales, creeks, and depressions and in the calculations of areas. The saving in cost of construction and operation, however, will far offset that of surveying. One advantage of using the drainways and swales for land lines is that, when it becomes necessary to build a drainage system, these natural drainage channels will function as the main arteries of the system, and the original survey notes of these drainways will be already run out, platted, and closed. On such a subdivision a drainage system can be built without

TABLE I. ESTIMATE OF STRUCTURES REQUIRED ON ROADS, CANALS, AND DRAINS FOR AN AREA OF ONE SQUARE MILE

STRUCTURES REQUIRED	RECTANGULAR PLAN	NATURAL PLAN
Bridges	4	5
Drainage culverts on roads	3	3
Drainage culverts on laterals	0	1
Service gates	58	34
Checks and drops	53	30
Checks	16	6
Head-gates	8	2
Siphons under roads and laterals	6	9
Total number of structures	148	90
CANAL LENGTHS REQUIRED		
Length of canals in miles	1.18	1.26
Length of service laterals in miles	3.41	1.45
Total length in miles	4.59	2.71

SMALL TIMBER CHECK AND DROP IN A FARMER'S HEAD-DITCH

"FURRO-TUBE" THROUGH THE BANK OF A FARMER'S HEAD-DITCH

YOUNG ORCHARD IRRIGATED BY THE FURROW METHOD

damaging property, dividing farms, or requiring bridges for roads, or flumes or siphons for farm laterals. Also, there will be fewer "eye-sores" caused by the high and unsightly banks of excavated material thrown up across these farms.

GENERAL PUBLIC UNINFORMED

In studying land lines on the map, some buyers criticize them from all angles and points of the compass, but surprisingly few people can tell directions when in the field or have any idea of the direction of land lines, or whether they agree with the cardinal points of the compass. The colonization department in selling land found very few objections to the plan and usually forestalled those that might have been made by stressing the advantages of the method at the beginning of all sales talks.

Those chiefly opposed to the plan are the abstract-of-title searchers and the title attorneys. Their objection is that the new land lines very seldom follow the old original grant or survey lines, except perhaps on the boundary of the area being subdivided. This criticism applies less to conditions in Texas than elsewhere in the country, because the old grant lines in that state are very indefinite, and no matter what subdivision plan is adopted the difficulty remains the same. Finding these original grant lines is a matter of getting the oldest surveyor in the community and using his "art" rather than science and technical training.

Many of the soils of the arid and semi-arid regions dissolve very rapidly and are extremely subject to erosion. This is true of most of the soil in southwestern Texas, and especially on the Medina Project. The gutters of roads located on hills erode quickly, and it is a difficult and expensive matter to control them. In the plan recommended, only a minimum percentage of the road mileage is hilly, most of the location being on easy gradients that cause no damage to the gutters by erosion.

It is not contended that an irregular subdivision on natural lines would be advisable in all cases. Where the land is very smooth, free from all swales, valleys, creeks, or washes, and the slope is less than from 5 to 10 ft. per mile, it is probable that a rectangular plan can be economically followed. In any case, however, all drainways, swales, and creeks should form land lines where possible. It is also advised that laterals following a "grade-contour" around a hill or along a slope, or those following a ridge, be paralleled by a road and a land line.

TABLE II. COMPARATIVE ESTIMATE OF QUANTITIES AND COSTS FOR DEVELOPING ABOUT 5,000 ACRES GROSS

ITEM	RECTANGULAR PLAN	NATURAL PLAN
Acreage in farms, net	4,558	4,777
Number of lots	250	250
Service gates	479	266
Canal length, in miles	52	35
Canal excavation:		
Amount, cubic yards	189,800	153,500
Cost	$37,380	$31,000
Canal structures:		
Total number	1,445	810
Total cost	$91,380	$53,730
Right-of-way, acres	326	211
Total cost of canals, including engineering, at $150 per mile	$148,200	$98,760
Cost per acre for canal construction	$32.51	$20.67
Road and farm bridges, and drainage culverts:		
Number	180	65
Cost, including road work	$41,010	$26,780
Cost of boundary surveys, subdivision, office calculations:		
Per acre	$1.50	$3.00
Total	$6,840	$14,330
Total cost of roads, drainage, and engineering on subdivision	$47,850	$41,110
Grand total	$196,070	$139,880
Total cost per acre	$43.00	$29.28

Reservoirs on the Upper Mississippi River

Constructed and Operated by the United States

By HIBBERT M. HILL, ASSOC. M. AM. SOC. C.E.
and RALPH P. JOHNSON, JUN. AM. SOC. C.E.
ENGINEER AND JUNIOR ENGINEER, RESPECTIVELY, U.S. ENGINEER OFFICE, ST. PAUL

FOR nearly half a century, the U.S. Government has operated a system of reservoirs in northern Minnesota for the purpose of increasing the low flow of the Mississippi River near St. Paul. This article by Messrs. Hill and Johnson gives the historical background of the operation of these reservoirs, and a description of them as they now exist. They have been a great aid to nagivation, and the increase in the low flow of the Mississippi has been an important factor in the hydro-electric development of the river and in the improvement of sanitary conditions at the Twin Cities. When the Upper River is completely canalized in accordance with the Government's program, the operation of these reservoirs will be materially changed.

SINCE 1884 the United States has maintained a system of reservoirs at the headwaters of the Mississippi River, in Minnesota, for the purpose of aiding navigation on the streams below. The system, the location of which is shown in Fig. 1, now contains six reservoirs with a total capacity slightly in excess of 2,200,000 acre-ft. Although it is unique both in purpose and capacity, its existence is not generally known to engineers.

This reservoir project was originated by Congress in the River and Harbor Act of June 18, 1878, which ordered a preliminary examination of the sources of the Mississippi, St. Croix, Chippewa, and Wisconsin rivers, "... to determine the practicability and cost of creating and maintaining reservoirs upon the headwaters of said rivers and their tributaries for the purpose of regulating the volume of water and improving the nagivation of said rivers, and that of the Mississippi River. ..."

After extensive reconnaissance in what was at that time a wild and inaccessible region, a system of reservoirs was outlined which included the possibility of locations on the Mississippi, St. Croix, Chippewa, and Wisconsin rivers. Subsequently, in 1887, the Chief of Engineers, U.S. Army, recommended that the proposed reservoirs on the St. Croix, Chippewa, and Wisconsin rivers, should not be constructed by the Government. However, many of the sites selected on these rivers have since been developed by private concerns for power or power reservoir purposes.

The Government reservoirs are natural lakes at whose outlets controlling dams have been constructed. The original dams, built under great difficulty, were of timber crib construction, but the five dams so built were reconstructed of concrete about the year 1900.

At the time of construction of the reservoirs, the region in which they are situated contained no railroads and but few and poor roads. The streams provided the principal avenues of travel, and at low water they were often barely navigable by canoe. The extensive logging operations being carried on in the reservoir area benefited greatly by the construction of this system, and immense quantities of timber were floated down the Mississippi from the reservoir region. In connection with these logging operations and with the settlement of the area, the upper tributaries of the Mississippi were navigated by various small boats and, in the more accessible reaches, by small steamboats. Navigation of this character practically ceased about 1915 with the cessation of lumbering in the region and the improvement of highways.

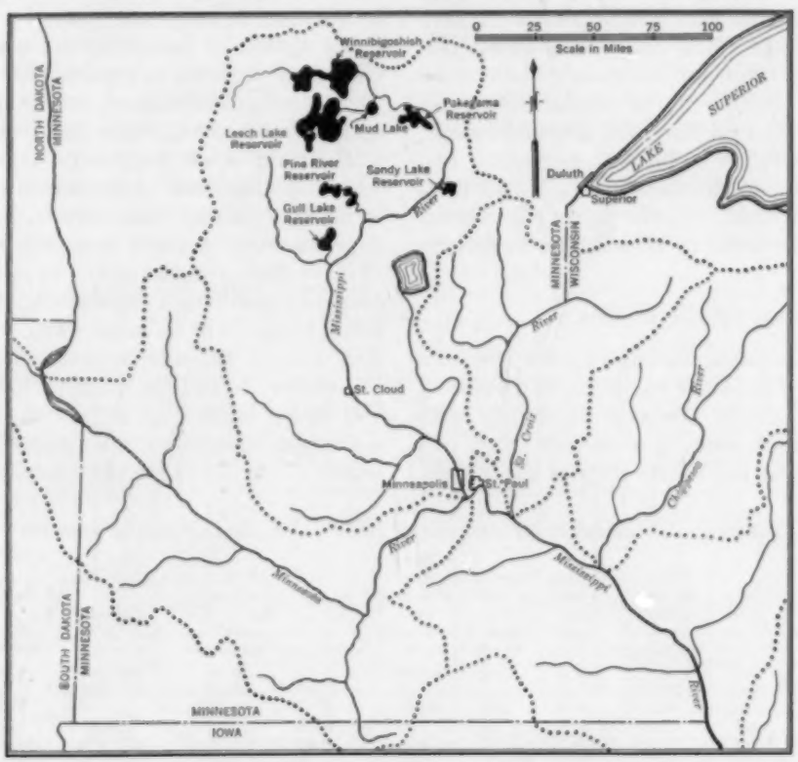


FIG. 1. RESERVOIRS ON THE UPPER MISSISSIPPI RIVER
Gross Capacity 2,200,000 Acre-Ft.

The head of through Mississippi River navigation, except for that just described, is now at Minneapolis, which is about 200 miles below the lowest reservoir and 400 miles below the uppermost. Navigation from Minneapolis south, like that in the reservoir area, was very extensive during the lumbering days, but

virtually ceased about 1915. In 1927, however, interest in navigation revived with the establishment of regular service to Minneapolis by the Inland Waterways Corporation. By maintaining navigable depths, the reservoir system greatly aided the earlier traffic and latterly has aided in the effort to revive navigation on the Upper Mississippi.

POKEGAMA RESERVOIR DAM, NEAR GRAND RAPIDS, MINN.
Capacity of Reservoir, 120,000 Acre-Ft.

The total Government expenditure for the construction, maintenance, and operation of the reservoirs, to June 30, 1930, has been $2,820,551.74. The annual cost of maintenance and operation is about $25,000.

During recent years the reservoirs have been operated to regulate the 30-mile reach between St. Paul and the mouth of the St. Croix River. Recently, however, the canalization of this 30 miles was completed by the construction of the Hastings Lock and Dam, which permanently removes the need for assistance there from the reservoir system. Below the St. Croix River, because of the increased natural flow and decreased slope, discharge from the reservoirs is both less effective and less needed than above, and further, all the upper river is eventually to be canalized. In the future, the operation of the reservoir system will therefore differ materially from that of the past.

TOPOGRAPHY OF THE REGION

The topography of the area surrounding the reservoir system is rolling, with but small variation in elevation. The area is entirely covered, to a great depth, with glacial till, a mixture of sand, gravel, and clay. In recent years the region at the headwaters of the Mississippi has undergone a great resort development, and is now visited annually by thousands of tourists, traveling largely by automobile over excellent highways. Game and fish are plentiful. The reservoirs, which constitute the largest bodies of water in the area, have many resorts, both public and private, on their shores. This development has led to increasingly greater demands for curtailment of the reservoir operation from the resort interests, desiring stable water levels.

The reservoir dams are all ordinary concrete structures of low head, built on piling, except in one case. Discharge in all the dams is regulated manually by a resident dam tender. The spillways are equipped at two dams with sliding gates and at three dams with stop-logs only. The remaining dam is equipped with Taintor gates. No power is developed at any of the dams.

The reservoirs were originally large natural lakes, and the reservoir volume is that included above the low-water elevation of the uncontrolled lake. As is shown in Table I, the reservoir depths are small, and their large capacities result from their great areas. Considerable portions of the reservoirs are very shallow, and a wide variation in shore line with varying stage results.

Operation of the dams is controlled and directed by the district office of the U.S. War Department at St. Paul, under regulations promulgated by the Secretary of War. Daily reports of conditions are mailed to the office from each dam; and these reports, interpreted with a knowledge of river conditions, form the basis for the orders issued from the district office, usually by telegraph. This system works very well. The greatest difficulty in operation results from the period required for the transit of water from the reservoirs to the head of navigation, approximately 6 days from the nearest reservoir, and 23 days from the farthest. It is thus necessary to predict river conditions considerably in advance, and faulty predictions result in some waste of water. The navigation season extends approximately from April 1 to November 10, and the usual period of reservoir discharge is from the latter part of July to the first of November.

Climatic conditions in the reservoir area are rather severe. The lakes freeze in late November and open in

TABLE I. GOVERNMENT RESERVOIRS AT THE HEADWATERS OF THE MISSISSIPPI

Reservoir	First Year of Operation	Outlet Miles Above St. Paul	Total Watershed Area Sq. Miles	Water Area When Full Sq. Miles	Required Minimum Discharge Sec-ft.	Maximum Permissible Discharge Sec-ft.	Gross Gage Limits In Feet Minimum	Gross Gage Limits In Feet Maximum	Gross Capacity Acre-ft.	Operating Gage Limits In Feet Minimum	Operating Gage Limits In Feet Maximum	Net Capacity Acre-ft.
Winnibigoshish*	1884	408	1,442	179.4	150	1,500	−0.60	14.20	997,000	6.00	14.20	652,800
Leech Lake*	1884	410	1,163	250.9	100	1,000	−0.69	5.24	762,700	1.00	5.24	582,500
Pokegama	1884	344	660	35.0	400	4,000	4.50	12.00	120,750	6.00	12.00	102,200
Sandy Lake	1895	267	421	16.6	10	500	0.78	11.00	72,550	7.00	11.00	37,900
Pine River	1886	199	562	23.7	10	500	2.30	18.50	177,500	11.00	15.00	54,400
Gull Lake	1912	168	287	20.5	10	150	1.00	7.00	70,950	5.00	7.00	25,950
Totals		...	4,535	526.1	430	5,150	...	...	2,201,450	...	...	1,455,750

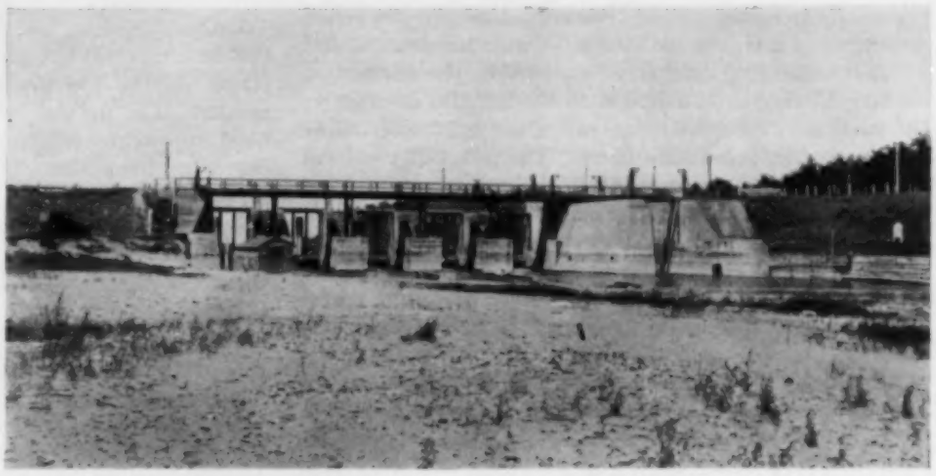
* These lakes discharge through Pokegama.

April, and from December first until the last of March there is practically no surface flow into them. Precipitation in the area amounts to about 25 in. annually, of which about 19 per cent falls as snow. Approximately 75 per cent of the precipitation falls during the six months from April to September, inclusive, and about 55 per cent of this falls during the four months from May to August. The average yield of the reservoirs is 4.80 in., or 19.5 per cent of the precipitation.

In comparison with the net yield, the capacity of some of the reservoirs is very large. This is particularly marked in the case of the two largest reservoirs, which have been full only once in their 46 years of operation. Very rarely has the maximum storage in Leech Lake exceeded 65 per cent of its capacity, or that in Winnibigoshish, 55 per cent of the capacity of that reservoir. Only in the case of Pokegama and Sandy Lake reservoirs does the mean annual yield exceed the reservoir capacity.

Because of the great ratio of area to depth, evaporation from the reservoirs is an important factor. During dry periods of the summer, it often exceeds the inflow by substantial amounts. Some few scattered observations on evaporation have been taken at the reservoirs, and a continuous record was begun in 1930. The records thus far indicate an average annual evaporation from water surfaces of about 36 in. per year. The importance of evaporation from the reservoirs, all of which have inflows approaching zero during dry seasons, can easily be seen. Assuming that the reservoirs are half full of water and that 6 in. evaporate during the month of July, the period of maximum evaporation, the water lost from the system in this way during the month would equal a continuous flow of 2,068 sec-ft. and amount to nearly 6 per cent of the gross capacity of the system.

Until 1930 the net mean annual inflow to the reservoir system, computed from the algebraic sum of the discharge and the change in storage, was 1,661 sec-ft., of which 899 sec-ft., or 54 per cent, flows through Winnibigoshish and Leech lakes. Because of their large areas, these two reservoirs have very great natural regulating qualities. It is interesting to note that the natural regulation of Winnibigoshish and Leech lakes would have a marked seasonal effect, and would often be felt from year to year. The natural regulating effect of the smaller reservoirs, while perceptible, would be much less noticeable than that of the two large ones.



WINNIBIGOSHISH RESERVOIR DAM FROM DOWNSTREAM
Nearly Half the Capacity of the System Is in This Reservoir

OPERATION OF THE SYSTEM

The total net inflow to the reservoir system is about 1,600 sec-ft. Since the reservoirs are not capable of complete control of their inflow, they can at best provide an assured annual flow of about 2,000 sec-ft. for 6 months, or 3,500 sec-ft. for 3 months, with a minimum flow of 430 sec-ft. for the remainder of the year. Because of channel and spillway limitations, the reservoir system, assumed full at the beginning of a peak period, could not be emptied in 6 months without exceeding the agreed

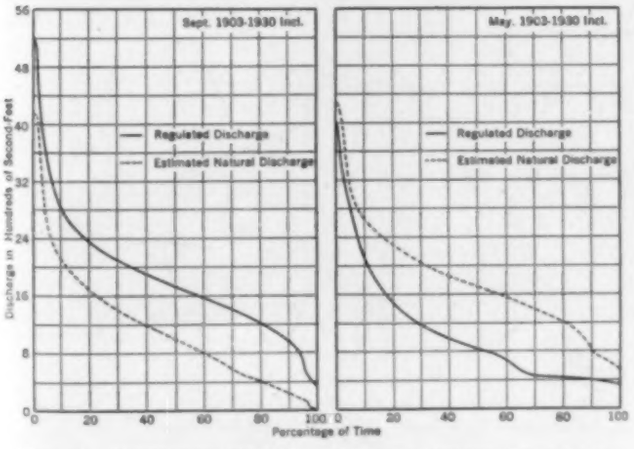


FIG. 2. DISCHARGE DURATION CURVES BELOW POKEGAMA RESERVOIR
Showing Effect of Regulated Storage

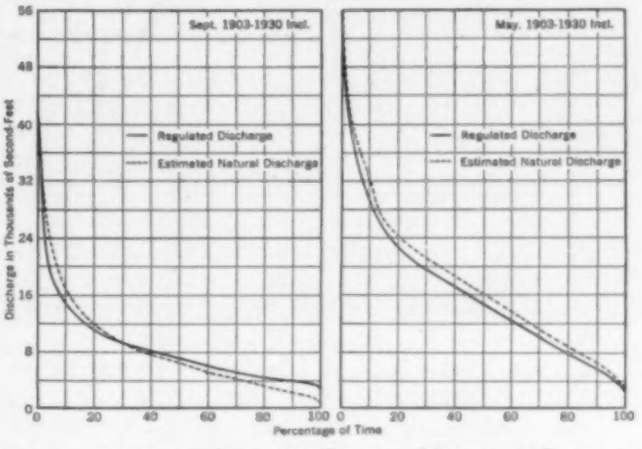


FIG. 3. DISCHARGE DURATION CURVES—MISSISSIPPI RIVER AT ST. PAUL, MINN.
Effect of Reservoir Storage Less Marked

maximum discharges, and the best that could be done would be to discharge 4,700 sec-ft. for 6 months, or 5,200 sec-ft. for 3 months. The latter amount represents the approximate maximum possible discharge from the reservoirs as limited by flowage rights.

Actual operation of the reservoirs has not proceeded according to a regular schedule. Water has been stored when possible and discharged as needed, the amount of discharge being proportionate to the amount in storage, the need, and the best judgment of the operating officer as to probable future conditions. The possibility of local flood damage has necessitated the predetermining of certain water stages of the reservoirs at the time of spring break-up, with the result that often the storage capacity has not been fully utilized. As a consequence of these practical difficulties, the actual discharge useful in the interests of navigation has been materially less than the seasonal discharge of approximately 3,000 sec-ft. of which the reservoirs are capable. In many critical periods the reservoirs have been of great assistance to navigation; in other critical periods they have been of little or no assistance. On the whole, however, they have had a very beneficial effect.

NAVIGATION AIDED BY RESERVOIR OPERATION

Up to this time, the reservoirs have been operated in the interests of navigation, that is, to increase river stages during the low-water period of the navigation season. The normal period of discharge has therefore been approximately from July 20 to November 1. In operating the system, it has of course been necessary to give some consideration to other interests, such as local flood control, fish and game life, resort activities, logging operations, and water power, but concessions made to these interests have heretofore been entirely overshadowed by the requirements of navigation.

In general, it may be said that reservoir operation in the past has not appreciably affected the flow during November, December, January, February, and March; has reduced the flow during April, May, and June, but has not appreciably affected the utilizable flow in these months; on the average has not much affected the flow during July; and has increased the flow during August, September, and October. In Figs. 2 and 3 is shown the average magnitude of these effects at two points during two typical months. At Pokegama Reservoir the Mississippi is completely controlled by the Winnibigoshish, Leech Lake, and Pokegama reservoirs, while an uncontrolled drainage area of 32,250 square miles intervenes between the reservoirs and St. Paul.

The effect of the reservoir discharge at St. Paul during 1929 is shown in Fig. 4. So far as navigation was concerned, this effect was to increase the water stage at St. Paul by approximately 2 ft. in the period from August 1 to November 10. The unregulated flow is, of course, computed. This daily discharge record illustrates very well the possibilities of the reservoirs in a normal year of low flow. The year 1929 was, however, followed by a year of still lower flow, with the consequence that the reservoirs were not able to maintain a uniform stage to the end of the navigation season, and their storage was completely exhausted. The year 1931 was one of record low flow in the area under consideration, and but little storage had been accumulated in the reservoirs. Fortunately, however, construction of the Hastings Lock and Dam had largely obviated the need for such storage.

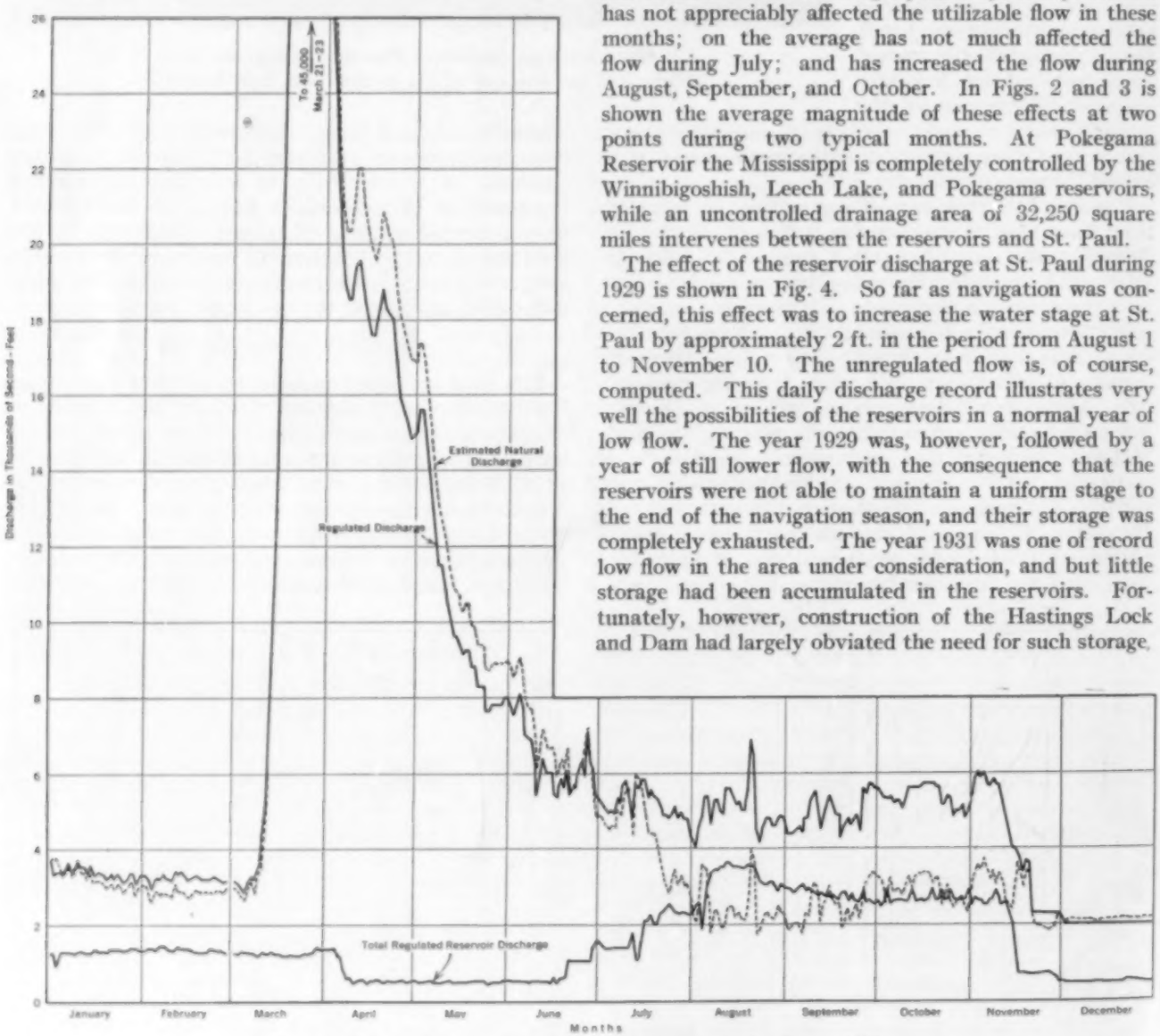


FIG. 4. DISCHARGE RECORD OF THE MISSISSIPPI AT ST. PAUL, 1929
Low-Water Stage Increased About 2 Ft.

as the reservoirs could have been of very little assistance during 1931, and navigation from the St. Croix River to the Twin Cities would have been a virtual impossibility in the absence of the Hastings Dam. In spite of this fact, the uninterrupted navigation of this reach in 1929 and 1930 was made possible by reservoir operation.

Between the reservoirs and St. Paul there are nine dams, at which a total of 126,745 hp. is developed. In addition, there are three plants on the Mississippi—at Moline, Ill., and Keokuk, Iowa, with a total capacity of 204,400 hp.—which are affected by the reservoir discharge. The plants above St. Paul have received the benefit of practically all the water released from the reservoirs for navigation purposes. This release has not been of maximum benefit in that it has not been possible to depend upon it to increase the prime power of the stream, but it has very materially increased the energy produced at these developments.

The Mississippi above St. Paul is not subject to destructive floods except at one locality. At this point peculiar local circumstances, beyond the control of the reservoirs, make it impossible for the system, even if operated solely for flood control, to do more than reduce the frequency and duration of floods. At and below St. Paul, where the maximum flood flow is about 117,000 sec-ft., the reservoirs have but little effect. For example, during the flood of 1927 it is estimated that the effective natural discharge from the reservoirs during the crest at Cairo, Ill., would have been 2,400 sec-ft. The actual discharge was 1,200 sec-ft., all of which could have been withheld under a flood control plan of operation. Withholding this amount would have affected the Cairo gage by a maximum of 0.02 ft.

Sanitation has not been appreciably affected by reservoir operation except at and near the Twin Cities, where a combined population of about 800,000 obtains its water supply from the Mississippi, and discharges its untreated sewage into the same stream. The stream flow, without aid from the reservoirs, has been ample for water supply purposes, but entirely inadequate to dispose of the sewage without creation of a gross nuisance. The operation of the reservoirs, by maintaining the flow during the hot months of summer, undoubtedly assisted in postponing the day when this nuisance became acute. Even if operated solely in the interests of sanitation, the reservoirs could at best only slightly ameliorate the existing nuisance. By proper future operation, they could, however, greatly reduce the fixed and operating costs of projected sewage disposal works.

RESERVOIR OPERATION JUSTIFIED

It would be extremely difficult, if not impossible, to gather data from which an evaluation of the total benefits arising from operation of the reservoir system might be derived. In an absolute sense the effect of the reservoirs has not been large but, relatively, their effect on the Mississippi above the St. Croix River has been marked. Reservoir operation, in conjunction with open channel improvement, was never able to satisfy entirely the demands of navigation, and has now been superseded as a basic method by other and more positive means. Nevertheless the reservoirs made possible navigation—however difficult—which otherwise would have been impossible and thereby contributed to the development of the territory involved by aiding a very considerable commerce. The cost of the reservoir system, judged by present standards, has been low, and there is little doubt that it has been amply justified.

DANUBE CANAL BRIDGE, VIENNA, FABRICATED AND ERECTED BY THE WAAGNER-BIRO, A.G.

This structure, a rigid-frame cantilever arch of plate-girder construction, over the Danube Canal in Vienna, was completed recently (1931). The anchor arms are completely restrained by anchorages in the masonry abutments and this restraint introduces complicated stresses in the girders entirely different from those in a simple plate-girder span. Three thousand tons of alloy steel were required. The bridge, which has a length of 90 meters (295 ft.), is 25.5 meters (83 ft.) wide. It is designed to carry a 32-ton car having a maximum concentrated axle load of 18-tons, or a total live load of 2,000 tons.

This information, as well as the photograph, was furnished by F. H. Frankland, M. Am. Soc. C.E.

Foundation Methods Involving Piling

A Rational Treatment of a Common Construction Problem

By ROBERT M. MILLER
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
SECRETARY, MACARTHUR CONCRETE PILE CORPORATION, NEW YORK

TOO often structures are meticulously designed above ground, only to be placed on foundations that have been designed with incomplete or inaccurate information. Foundations resting on piles that do not penetrate to a solid stratum are particularly susceptible to settlement, although it is difficult and frequently impossible to predict the amount. Because subsoil conditions may vary so greatly from point to point in the same foundation area, Mr. Miller advocates making foundation piling contracts flexible enough to permit the construction engineer to select, from the many types available, the piles best adapted to the conditions found. The advantages and characteristics of various types of piles are also described in Mr. Miller's article.

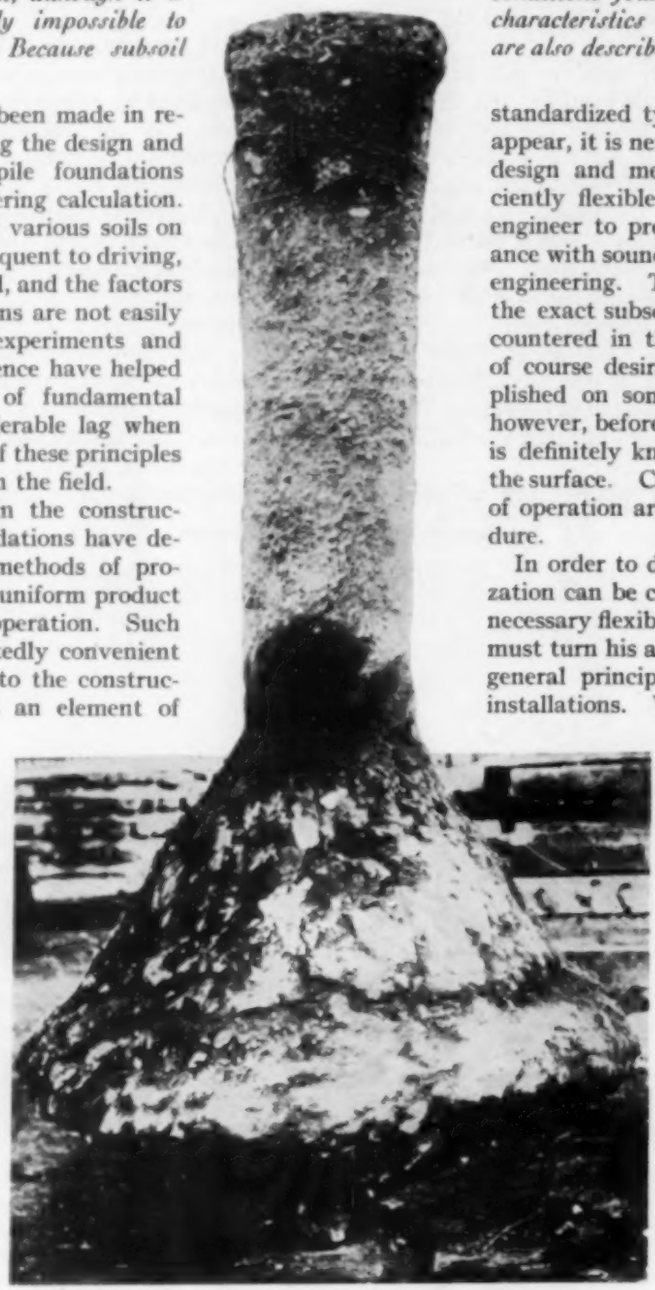
MANY efforts have been made in recent years to bring the design and construction of pile foundations within the range of engineering calculation. The matter of reactions of various soils on piles, both during and subsequent to driving, is however very complicated, and the factors that determine such reactions are not easily measured. While recent experiments and studies of recorded experience have helped toward an understanding of fundamental principles, there is a considerable lag when it comes to the application of these principles to conditions encountered in the field.

Companies specializing in the construction of pile and other foundations have developed certain standard methods of procedure in order to insure a uniform product as well as economy of operation. Such standardization is undoubtedly convenient to the designer as well as to the construction engineer. It contains an element of danger, however, in that it stimulates a tendency to adopt one type of piling and a restricted technic for all foundation piling problems. In fact, the results of formulas calculated to cover every case have appeared in many specifications, thus discouraging a proper analysis of the problems involved. The use of such specifications may lead responsible engineers and architects to question the sufficiency of piling in many instances where pile foundations would be entirely feasible.

No matter how convenient a single, highly standardized type of pile construction may appear, it is nevertheless desirable that both design and methods of operation be sufficiently flexible to permit the construction engineer to proceed at all times in accordance with sound and recognized principles of engineering. To anticipate in the design the exact subsoil conditions that will be encountered in the course of construction is of course desirable and is actually accomplished on some projects. In most cases, however, before construction is started little is definitely known about conditions below the surface. Consequently, flexible methods of operation are essential to rational procedure.

In order to determine how far standardization can be carried without sacrificing the necessary flexibility, the foundation engineer must turn his attention to an analysis of the general principles fundamental to all pile installations. When it has been established what these fundamental principles are, the scope and limitations of possible standardization may be determined. Beyond these limitations, methods of operation must be left flexible.

In making this analysis, the engineer should remember that the use of piling constitutes a very old method of construction. Until recently, practice in pile foundations had been developed largely through a long series of gradual improvements in equipment, rather than through any change of attitude toward fundamental problems.



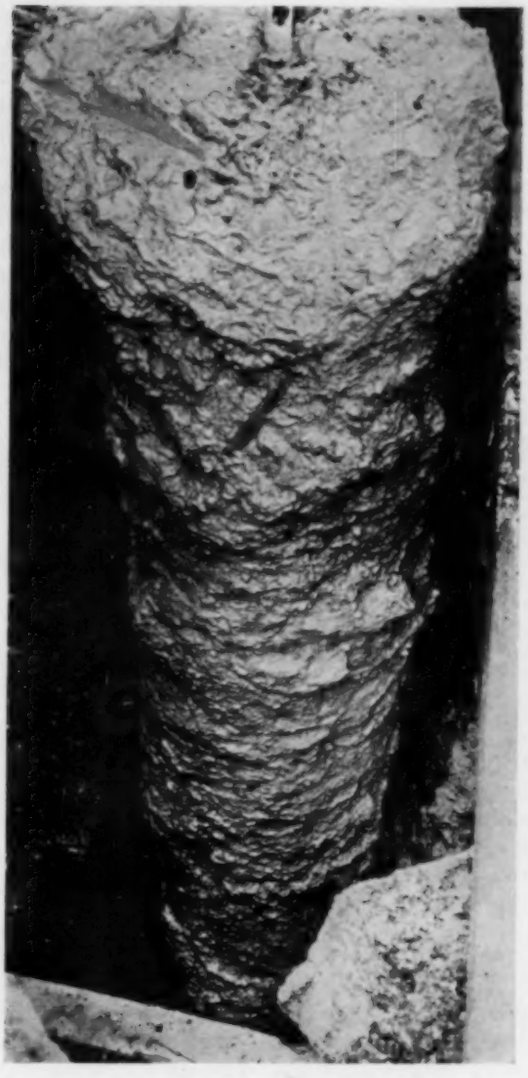
PILE WITH ENLARGED BASE SIMILAR IN SHAPE TO THE BULB OF PRESSURE

It is therefore to be expected that current methods will retain some erroneous practices, and it becomes all the more essential to approach foundation problems with a mind free from preconceived ideas.

DEVELOPMENT OF PILE TYPES

The use of piles to support structures can be traced back to prehistoric times. During the centuries there has been a gradual broadening of the field of usefulness of piling, and old practices have slowly been adapted to new conditions in the construction world. Until recently, the most significant change that had taken place was the discovery of new materials from which piles could be made. The oldest piles on record were of wood. Tall, straight trees were felled, stripped of their boughs and branches, and driven into the ground, small end first. Later, as concrete and steel became increasingly important in construction work, the pile industry adapted itself to the use of these materials.

The first automobiles consisted of old-fashioned buggies in which engines had been installed. This was because the current conception of a vehicle for highway travel was such a buggy. It was years before designers were sufficiently free from old habits of thought to design the specialized vehicles of the present day. Consequently, although the use of new materials of construction gave pile designers an opportunity to mold their product into such shapes as the functions of the piles might indicate, the natural tendency was to select the shape of the wood piles that they had been in the habit of using. For this reason, possibly, the tapered concrete pile came into use.



A COMPRESSED CONCRETE PILE SHAFT
The Rough Surface Increases Skin Friction

Although it is obvious that a tapered pile may sometimes be structurally desirable, many engineers have questioned its efficiency under certain soil conditions. In many foundations, for instance, piles are called upon to transmit the load of the structure which they support to a stratum of rock, gravel, hardpan, or other firm material underneath the softer soil which is exposed on the surface. Such piles act essentially as columns, and are known as end-bearing piles.

The inconsistency of tapering a column is probably what in the first place made engineers question the structural efficiency of tapered concrete piles under such conditions. However, where there is no definite tightening of the soil in the deeper reaches, the structural function of a pile is not that of a column, and a tapered pile is advantageous under such conditions. Piles driven in such soils are known as "friction piles." The reaction of the soil on a friction pile is complicated, depending upon certain physical characteristics of the soil itself, which are not easily measured. Experiments with the behavior of friction piles often give results which are apparently inconsistent and seem to defy attempts to derive general rules that will be applicable and accurate as a guide for field work.

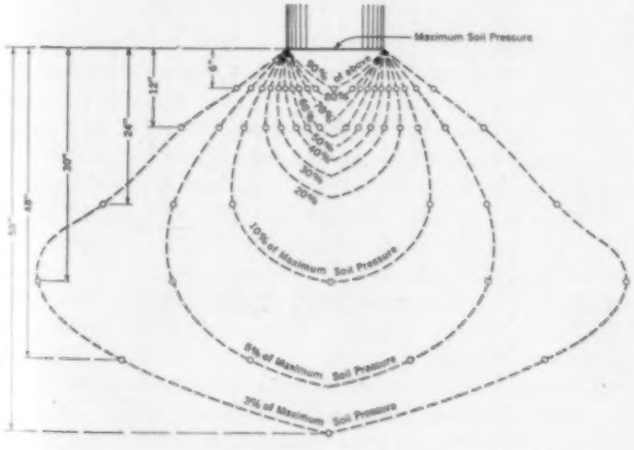


FIG. 1. LOAD DISTRIBUTION BY BULB OF PRESSURE
According to John F. Greathead, Assoc. M. Am. Soc. C.E.

EFFECTS OF PERMEABILITY OF THE SOIL

During the last decade, engineers have attempted to get at the fundamental principles involved in these problems. It has been shown by Charles Terzaghi, M. Am. Soc. C.E., in Vol. 93 of TRANSACTIONS (1929), that the hydrodynamic properties of the soil furnish an explanation of the apparent contradictions in the results of tests and experiments, and that the observed behavior of the soil becomes consistent when these properties are considered. All available data seem to bear out the contention that the degree of permeability of a soil determines to a large extent the manner in which the soil will react on a friction pile.

It is therefore convenient in a discussion of friction piles to make a broad distinction between two general classes of soils. In Class 1 may be included all soils that are easily permeable by water, such as gravel, coarse sand, and dry fills; and in Class 2, those soils which offer considerable resistance to the passage of

water, that is, finely divided materials, such as very fine sands, loams, clays, and silts.

In the soils in Class 1, the water pressures set up by the displacement of materials when a pile penetrates the soil almost instantaneously adjust themselves to static conditions, since water passes freely through the voids between the relatively coarse units of such soils. For the types of soil included in Class 2, however, the displacement of materials caused by the penetration of the pile builds up pressures that cannot be immediately dissipated. This is due to the smallness of the voids between the individual grains of these soils, which permits the water to seep through only at a very slow rate. For this reason the pressures set up within the soil by the penetration of a pile will constantly change with the passage of time, as the slow permeation proceeds.

A pile penetrates the ground in a series of rapid thrusts, each due to a blow of the pile-driving hammer. If the soil belongs in Class 1, there are created no unbalanced pressures, which must adjust themselves with the passage of time. Adjustment takes place immediately, and the static resistance which the pile will offer to further penetration under a load may be measured quite closely by the dynamic resistance offered to the sudden application of the pile-driving hammer. The relation between this dynamic resistance and the static load-carrying capacity of the pile is computed by means of various energy formulas, some of which have been simplified in order to admit of quick calculation in the field.

AMERICAN PILES WITH ENLARGED BASE

Where the soil is of a type included in Class 2, however, another factor becomes important. This is the back pressure set up at the point of a straight-shaft pile, and at the point and sides of a tapered pile, by the water as it is forced into the voids of the surrounding material. There is no ready escape, because of the low permeability of the soil. The rapid thrusts of the pile as it is driven down under the hammer build up pressure at the point, or point and sides—the soil under pressure having its voids completely filled with water—which cannot be dissipated with sufficient speed to reduce the pressure. This zone of pressure, with its confined water, acts as a unit in distributing the load over a considerable area. In this manner, the pile that is being driven may act as if some very dense stratum were being penetrated.

If the penetration under each blow of the hammer is measured and the *Engineering News* formula is applied, this dynamic resistance may be sufficient to indicate that the desired carrying capacity has been obtained. After the driving is stopped, however, the water oozes away from the pile point, or point and sides, because of the high pressure that has been built up; and this action will continue until the pressures have been completely equalized. When the zones of pressure, which distribute the load by means of effectively confined water, no longer exist, the value of the dynamic resistance, which acts during the driving of the pile, becomes much reduced, as static resistance.

It must not be concluded, however, that the loss of this dynamic resistance necessarily renders the pile unsafe,

STATIC PILE RESISTANCE IN TERMS OF DYNAMIC LOADS

The most widely used of these methods is the *Engineering News* formula. This is an energy formula, simplified to the point where it is true only within certain limits, and is the standard empirical formula used in this country for determining when a pile has been driven to a sufficient resistance. Many engineers have attacked its validity, but as an easily applicable rule-of-thumb, it is indispensable in pile-driving operations. As no other criterion of equal readiness or effectiveness is known, it probably will remain in use in its present form for some time to come.

It should be noted that, as far as the soils in Class 1 are concerned, the *Engineering News* formula is fundamentally sound, as has been shown by careful laboratory experiments conducted in Germany by Dr. Carl Zimmerman. They have established the relation between dynamic and static resistance to penetration for Class 1 soils, and have demonstrated the possibility of computing pile capacity from driving resistance under these conditions.

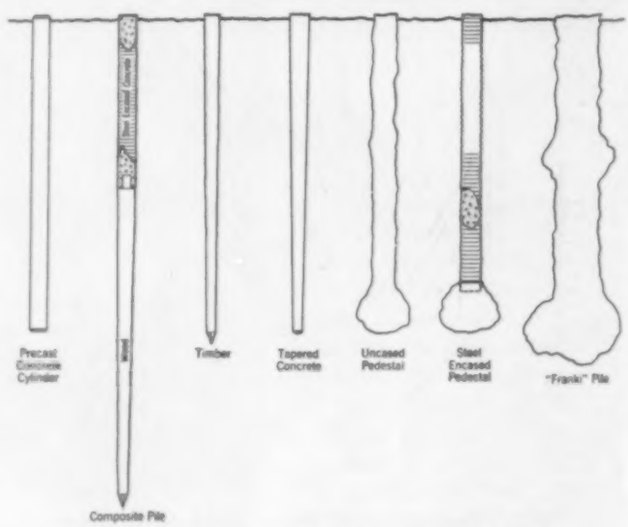
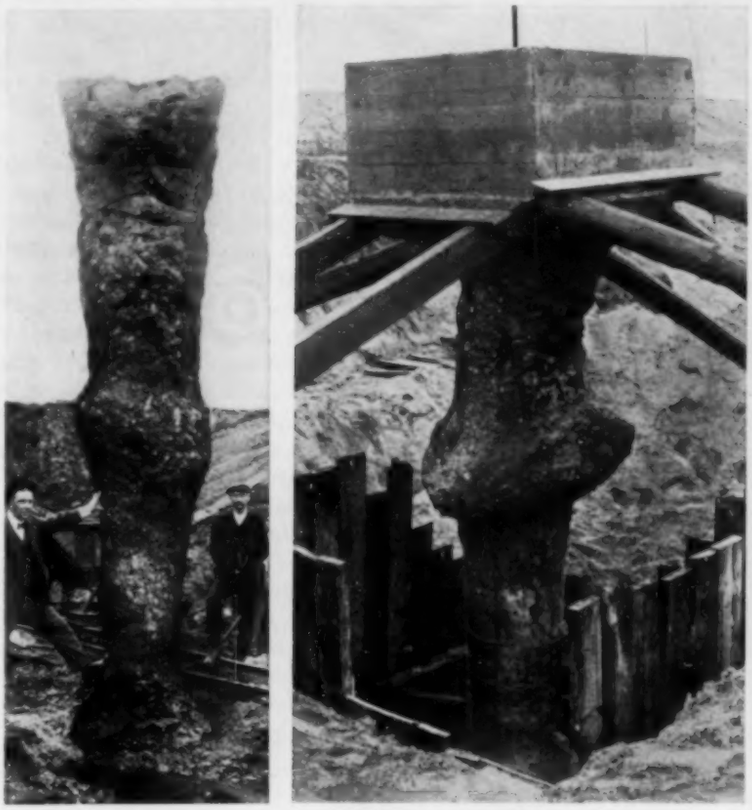


FIG. 2. SOME TYPES OF FOUNDATION PILES

for as the pressure is dissipated through seepage, a compensating action takes place along the pile shaft. While the pile is being driven, and as long as there is excessive pressure, a film of water is in constant motion along the pile shaft, so that there is an avenue of escape for part of the confined water. Thus the surrounding soil is prevented from settling in around the pile shaft and developing skin friction against the surface of the pile. In effect, it lubricates the pile in a manner similar to the process of jetting it with water. As soon as the pressures have become equalized, however, this flow along the shaft stops, and the soil settles against the surface of the pile, gripping it closely.

Experience has indicated that the increase in frictional or static resistance is not enough to compensate for the loss in dynamic resistance. It therefore appears that the use of the energy formula for piles depending upon their side frictional resistance for their carrying capacity is permissible for soils in Class 1, but is uncertain for soils in Class 2, or for those combining the two classes. The uncertainty, however, is removed entirely if the pile point is driven to a dependable substratum of rock, gravel, hardpan, or similarly safe material. When this is done, skin friction value may be considered merely as an additional factor of safety.



EUROPEAN PILES OF RAMMED CONCRETE

REGAINING BULB END ACTION

At times it is not practical to drive to solid bottom, and for such cases a method is available whereby the zone or bulb of pressure which the pile builds up can be maintained as a permanent feature of the pile. If, instead of forming a bulb of compressed water-bearing material, a corresponding bulb of concrete is hammered out at the point of the pile, the concrete will set and the load-distributing properties will remain permanently with the pile. This aim is achieved by pouring a charge of concrete into the bottom of the driven casing, placing the core upon the concrete, and forcing it into the surrounding soil by driving upon the core. This is the principle of several pedestal piles used so widely in this country and abroad. That the bulb of concrete actually does replace the "bulb of pressure" and function as such is strikingly shown in the illustrations of piles with bulbs of various sizes which have been excavated. In Fig. 1 are shown the "bulbs of pressure," as computed by John F. Greathead, Assoc. M. Am. Soc. C.E , and published in TRANSACTIONS, Vol. 93 (1929), page 335.

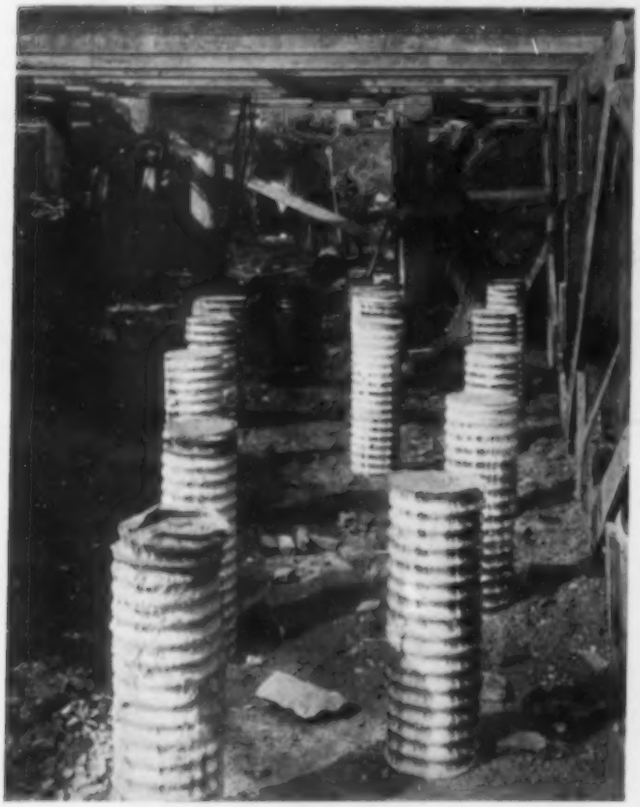
A comparison of the lines of equal pressure in Fig. 1 with the actual outlines of the bulbs of excavated piles shows a striking correspondence. Assuming the use of equal forces in hammering out the pedestals illustrated, it must be concluded that their size and shape depend upon the resistance set up by the surrounding soil and its homogeneity. Obviously, the large pedestal shown on page 304 was made in soft and homogeneous soil.

If sufficient carrying capacity must be developed to carry the load without penetrating to hard bottom, in soils other than Class 1, the problem becomes one of designing a pile that will develop the greatest possible static resistance. This static resistance depends upon the following factors: (1) the area upon which the friction acts, (2) the coefficient of friction between the surface and the material in contact with it, (3) the pressure with which the soil is forced against the surface, and (4) the possible carrying capacity of the material at the point of the pile.

Cylindrical piles have an advantage over tapered piles of equal butt diameters as far as frictional area is concerned. Particularly is this true in the case of oversized piles formed under compression in plastic soils. In Fig. 2 are shown various types of foundation piles.

In considering the coefficient of friction between the pile and the soil in contact with it, it is obvious that the rougher the surface, the greater the coefficient of friction, as well as the greater the area upon which friction acts. In the case of the rough, warty "Franki" pile, made of rammed concrete, and used so effectively abroad, it is stated that the coefficient of friction of the soil against the concrete is the same as that of soil on soil, the soil being in effect under shear. It is estimated that this coefficient of friction is four times as great as that of a pre-cast pile, or other pile of like smoothness of surface. Extremely high coefficients of friction are also secured in concrete piles without metal envelopes. In this country, such piles are formed of dry concrete forced into place under heavy compression. The rough exterior surface of this type of pile is illustrated.

In very soft material, or in material having a decided lateral movement under contiguous pile driving, the use of concrete against soil is often inadvisable. Under such conditions, a strong metal shell is desirable, having the greatest possible coefficient of friction against soil. For this purpose, a corrugated metal pipe is found effective, as the soil squeezing in and around the corrugations is



CORRUGATED METAL SHELLS FILLED WITH CONCRETE

under shear, although not to such an extent as with the rough shaft of a compressed concrete pile.

In the case of a pile shaft of compressed concrete, and to a lesser degree in other types of piling, the back pressure of the surrounding soil increases the coefficient of friction. The permanent value of this factor depends upon the character of the soil. In certain clays, as Terzaghi points out, the unbalanced pressures set up by driving may not be dissipated for many years, possibly not even during the life of the structure. This factor is, however, so uncertain of permanent results that it should be thought of merely as an additional factor of safety.

As the spreading of a foundation decreases the unit load placed upon the soil, so also does the use of the bulb or pedestal of concrete at the point of the pile decrease the unit load upon the soil and increase the carrying capacity of the pile. The actual increase in the carrying capacity of a pile effected by the use of the bulb is not often exactly determined. Tests have indicated that the addition of a pedestal may double or treble this capacity. A large bulb is advisable for use in soft soils and a smaller one in firmer materials. The plasticity of the soil itself largely controls the size of the pedestals.

It is thus possible for the engineer to combine in his design of piles such shape, size, materials, and methods of placing, that the piles will carry the designed load with safety under difficult conditions. It should be pointed out again that the static load capacity of a friction pile for the soils in Class 2, or for combinations of soils in Classes 1 and 2, is not definitely ascertainable by the use of the energy formulas, and that every possible factor of safety should be used. Under such conditions, any skimping of pile sizes or lengths should not be considered.

Tests made on construction work in Brussels reveal the fact that single "Franki" piles, combining a large, rough shaft and bulb of compressed concrete, have carried from 275 to 330 tons apiece. These piles, from 29 to 31 ft. long, were formed in plastic clay overlaid with a 13-ft. layer of clay. In this country building codes so limit the allowable load on a pile that it is impossible to take full advantage of the great capacity of this type of pile. Foundation designers here are restricted by the regulations of building departments and others limiting the allowable load on cast-in-place piles to 30 or 35 tons. Abroad, this condition does not generally exist, for the design of foundations is in the hands of the architect and engineer, who may plan to fit conditions, using cast-in-place piles with working loads of 100 tons and over.

Foundation engineering has always been, and still remains, the least understood of any of the branches of the profession. In spite of this acknowledged fact and of the obvious truth that the stability of a structure depends upon its foundation, there is a startling contrast between the methods of design used above and below the foundation line. When the care used in the design of columns, beams, and connections above ground is compared with the methods used in the design of the foundations, based too often upon incomplete and erroneous data, the inconsistency is apparent. It is not surprising that some structures, carefully designed above ground, settle unevenly.

It is always economical to make a thorough preliminary subsurface survey before preparing foundation plans and construction contracts. Even with the best of test borings and an abundance of test piles and static load tests as a basis for the design of foundation piling, it is seldom safe to assume that any one type of piling, unless driven in Class 1 material or to a solid substratum, will insure foundations that will not settle. On the contrary, conditions in the field often change so abruptly that the construction engineer should be supplied with a contract that is flexible. It has been found effective as well as economical to include in piling contracts several types of piles, leaving to the construction engineer the decision as to which type is dictated by the conditions.

Such a contract might assume the use of concrete piles placed under compression without a metal sheath, with the provision that, if a metal envelope is found necessary, an additional charge per linear foot of pile will be made for the sheath. There should be a further provision that, if other types of piles are found advisable, a stipulated unit price will be paid for them. Such a contract should include piles suitable for soils in Class 1 and Class 2, or a combination of the two classes, as well as long piles reaching to a solid and dependable substratum. With a flexible agreement combining the previously mentioned alternatives, the construction engineer can approach his problem with confidence.

GARDEN STREET BRIDGE, OVER THE COMAL RIVER

A Unique Three-Span Rigid-Frame Bridge

Reinforced-Concrete Highway Structure at New Braunfels, Tex.

By J. W. BERETTA

JUNIOR AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, SAN ANTONIO, TEX.

INSTEAD of the usual deck-slab structure simply supported on piers, a rigid-frame continuous span was designed by Mr. Beretta for the bridge over the Comal River, recently opened for traffic by the city of New Braunfels, Tex. The principal features of this reinforced concrete structure of interest to engineers are the continuous reinforcement of the ribbed deck, 164 ft. long from abutment to abutment, and the attachment of the deck to the reinforced piers so that they resist approximately half the bending moment of the central span. Negative bending moments are resisted by soffit slabs added beneath the ribs for a short distance each way from the piers. The shore ends of the bridge are free to move on bronze slide plates resting on the buttressed retaining-wall abutments.

AS far as can be determined, the first three-span, rib-type, rigid-frame bridge to be built is that across the Comal River at Garden Street, New Braunfels, Tex., which has a total length of 154 ft. $1\frac{1}{4}$ in. measured perpendicularly from the face of one abutment to that of the other. As the structure is on a 20-deg. skew, the length along the center line is 164 ft. The bridge is on a $1\frac{1}{2}$ per cent grade.

As shown in Fig. 1, it consists of a center span 82 ft. from center to center of piers, and two side spans each 41 ft. from the center of the pier to the face of the abutment.

The over-all width of the bridge is 31 ft., which provides a 20-ft. roadway and two sidewalks each 4 ft. 4 in. wide. The base for the concrete handrail has a width of 14 in., and the center-span roadway ribs have a depth of 32 in. at the center and 48 in. at the springing line. The end spans have a depth of 18 in. at the center and 48 in. at the springing line.

PROVISION MADE FOR EXPANSION

In the design of this bridge, the center span was assumed to be fixed at the ends because of the restraint of the two end spans and because of the rigid attachment of the floor slab to the piers. The abutments, being built free from the bridge proper, are simply retaining walls and supports for the side spans. Bronze bearing plates have been provided for the top of the abutments so that expansion can occur by a movement at both ends.

A combination of the principle of the rigid frame and that of horizontal continuity has been utilized in the design. The structure has been proportioned so that approximately one-half the end bending moment in the center span is resisted by a reverse moment in the side spans, using principles of continuity, and the other half of the bending moment in the center span is resisted by the piers, using the principle of the rigid frame. To assure the existence of this condition of restraint, the moment of inertia and the length of the members were taken into account.

Wherever the bending moment is positive, advantage was taken of the roadway slab to design the ribs as T-beams. Near the piers, where the bending moment is negative, a soffit slab was used to act as an inverted T-section. The soffit slabs are 6 in. thick; the soffit slab for the center span extends out 14 ft. beyond the center line of the pier, and that for the side spans extends out 8 ft. For lateral bracing, four diaphragms 6 in. in width are provided between the ribs in the center span, and two are used in each end span.

DEAD LOAD REDUCED

The lighter rib type of construction was selected to reduce the dead-load stresses, which were found to be about three times the live-load stresses. In order to further reduce the dead load, concrete with an ultimate 28-day strength of 3,000 lb. per sq. in. was specified. A unit compression strength of 1,200 lb. per sq. in. in bending

was used for the concrete. The reinforcing steel was designed for a working stress of 18,000 lb. per sq. in. The full maximum live-load stresses were used, plus 30 per cent for impact from two trains of 15-ton trucks headed

FALSEWORK AND FORM WORK FOR THE NEW BRAUNFELS BRIDGE

by a 20-ton truck, assuming that each train load was carried on any two ribs.

FOUNDATION CONDITIONS

The structure stands on an extremely hard blue clay that is almost a shale. The maximum pressure on the soil does not exceed 5,000 lb. per sq. ft. except under conditions of extreme high water, when the pressure at the downstream edge of the center piers may run as high as 7,600 lb. per sq. ft. A fin or rib is provided on the footings as an added safeguard against slipping. Because of the formation of the blue clay foundation, it was necessary to make the two piers of different lengths, which fact complicated the calculations considerably.

The construction of the abutments was rather unusual in two respects. The first was that the retaining wall had a very thin face, and was buttressed both in front and in the rear. The front buttresses were low enough so that they did not show above the surface of the river bank. By the use of this double system of buttresses the bottom or base slab was kept thin, and it was possible to use the full value of the weight of supported earth.

The second peculiar feature of the abutments concerned the details of span supports. As the span was of rib construction, the load had to be concentrated on bearing plates at the points of bearing of the ribs on the abutments, as was previously mentioned. To provide anchorage against both side slip and any possible uplift—

ROADWAY FORMS READY FOR REINFORCING STEEL

which, however, was not expected—the span ribs, in the form of a monolith, were built into a horizontal girder resting on the abutment. This horizontal girder extended into pockets left in the abutment when it was poured.

BRONZE SLIDE PLATES ON ABUTMENTS

To assure that there would be no bond between the span structure and the abutments and thus to allow free movement on the bearing plates, tar paper was laid on the abutments, covering them completely except for the

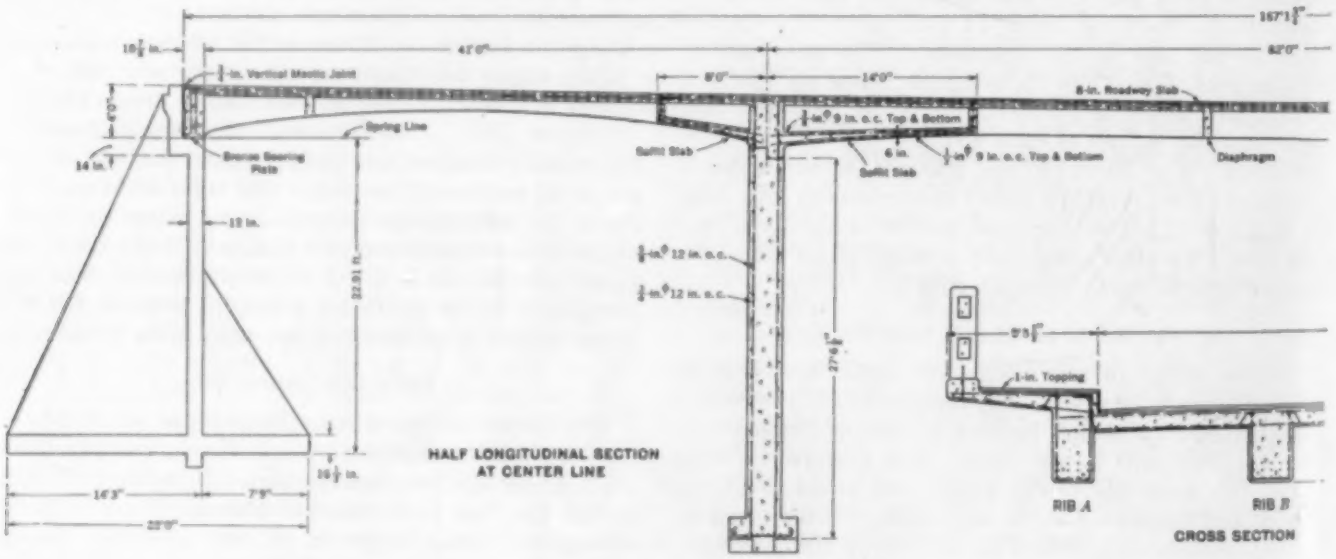


FIG. 1. HALF LONGITUDINAL SECTION ON CENTER LINE

part occupied by the bronze bearing plates. This was an important feature of the design, as it was assumed that the structure would simply expand or contract on both abutments from the center of the bridge. The vertical faces of the pockets were covered with three-fourths of an inch of mastic joint filler, thus permitting expansion and preventing bond. The under faces of the pockets in the abutments were painted to prevent bond with that part of the span which was poured into the pockets. Later there was ample proof of the success of the precautions

FLOOR STEEL IN PLACE, HALF OF CONCRETE POURED

taken in this joint. The expansion and contraction of the bridge due to changes of temperature between noon and midnight was observable, the cracks opening and closing as the temperature varied.

This movement meant that there was a horizontal thrust on the pier footings resulting from temperature changes. Had these footings been very wide, there would have been changes in the soil bearing of the piers. Since they were relatively narrow, however, they acted almost like a hinged joint. To assure that the horizontal thrust would be properly compensated, it was carefully ascertained that the footings were in solid blue clay and that the under-rib was well built. The whole footing of the piers was surrounded by clay in its natural state, the hole being cut to the exact size.

When the forms for the structure were removed, the settlement at the piers and abutments was too small for

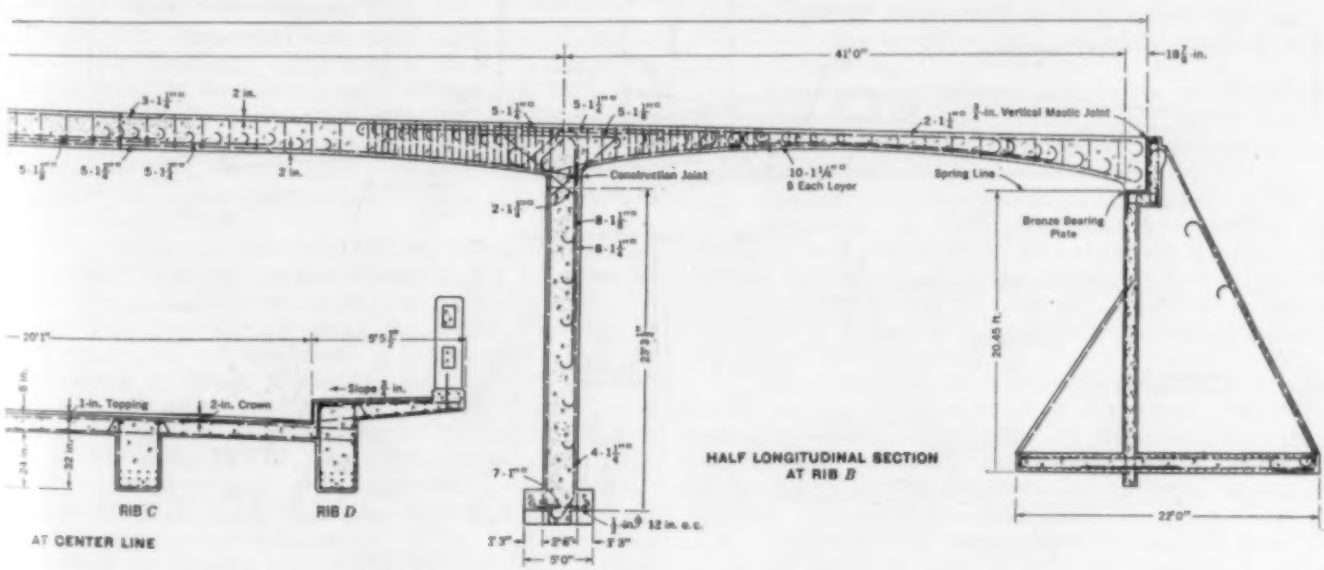
THE COMPLETED STRUCTURE

measurement, and that at the center of the main span was approximately three-eighths of an inch. The side spans on one end showed a slight rise of one-sixteenth of an inch, and those on the other end showed no measurable change.

BRIDGE BUILT FOR LESS THAN APPROPRIATION

The city of New Braunfels appropriated $30,000 for an arch-type bridge with a shorter central span at this location, but later estimates indicated that a rigid-frame structure could be built at a cost of between $23,000 and $24,000. The contract was awarded the low bidder, A. C. Moeller, of New Braunfels, Tex., for the sum of $20,425.02, exclusive of the engineering fee.

The structure was designed under my direction by W. E. Joor, vice-president of the J. W. Beretta Engineers, Inc., San Antonio, Tex., for the city of New Braunfels. R. S. Jahn was the city engineer and Jeremiah Schmidt, New Braunfels, was the advisory architect.



AND HALF LONGITUDINAL SECTION AT RIB B

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of everyday experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

Solving Problems of Heaving and Settling on Michigan Roads

By the late VICTOR R. BURTON

DEPUTY STATE HIGHWAY COMMISSIONER OF MICHIGAN

With the use of modern rigid pavements, difficulties due to uneven settlement on the one hand, and to heaving because of frost on the other, have been particularly vexing to the highway engineer. How Michigan attacks these difficulties was described by Mr. Burton at the Seventeenth Annual Conference on Highway Engineering, held at the University of Michigan in February 1931. The present notes are abstracted from his paper.

ABOUT 50 per cent of the failures of Michigan's pavements are due to frost and about 30 per cent are due to settlement. Recently, however, the problem of settlement in peat marshes has been quite successfully solved, especially in view of recent developments concerning a new method of accelerating settlement. The objection to dynamiting is that, in many instances, the peat is compacted rather than displaced by blasting and subsequent settlement may occur as the peat gradually takes up water. The new method involves jetting water into the highly compressed peat beneath the fill, thereby creating a tendency for the material to flow under the superimposed load. This method has been used at several locations with very encouraging results.

One particular advantage which jetting appears to have over dynamiting lies in the fact that the jets can be lowered to any desired position beneath or alongside the fill. For example, in situations where the marsh bottom slopes rapidly across the roadway, the jets can be set on the upper side only and thus can accentuate settlement without the invariable loss of fill material down the slope away from the road line.

At the location shown in Fig. 1, it was not possible to settle the fill by blasting because of the adjacent bridge structure resting on piling in the marsh. The pressure of the fill alone against the piling had produced a very slight movement of the structure, and it was therefore necessary to resort to a method whereby settlement would be effected gradually and without a lateral shifting of the fill. The jetting operations were finally discontinued for fear that the bridge might be damaged before complete displacement of the peat was effected. It will be observed, however, that almost complete penetration was obtained near Station 537.

The problem of frost heaving was one which required a great deal more study and was considerably more difficult. It has been a matter of opinion that this heaving could not be corrected by tile drainage because the phenomenon is purely capillary in nature, and to a certain extent this is true. In Michigan, however, many serious heaves have occurred in fine to fairly coarse sands, to which water was fed under a hydrostatic head by

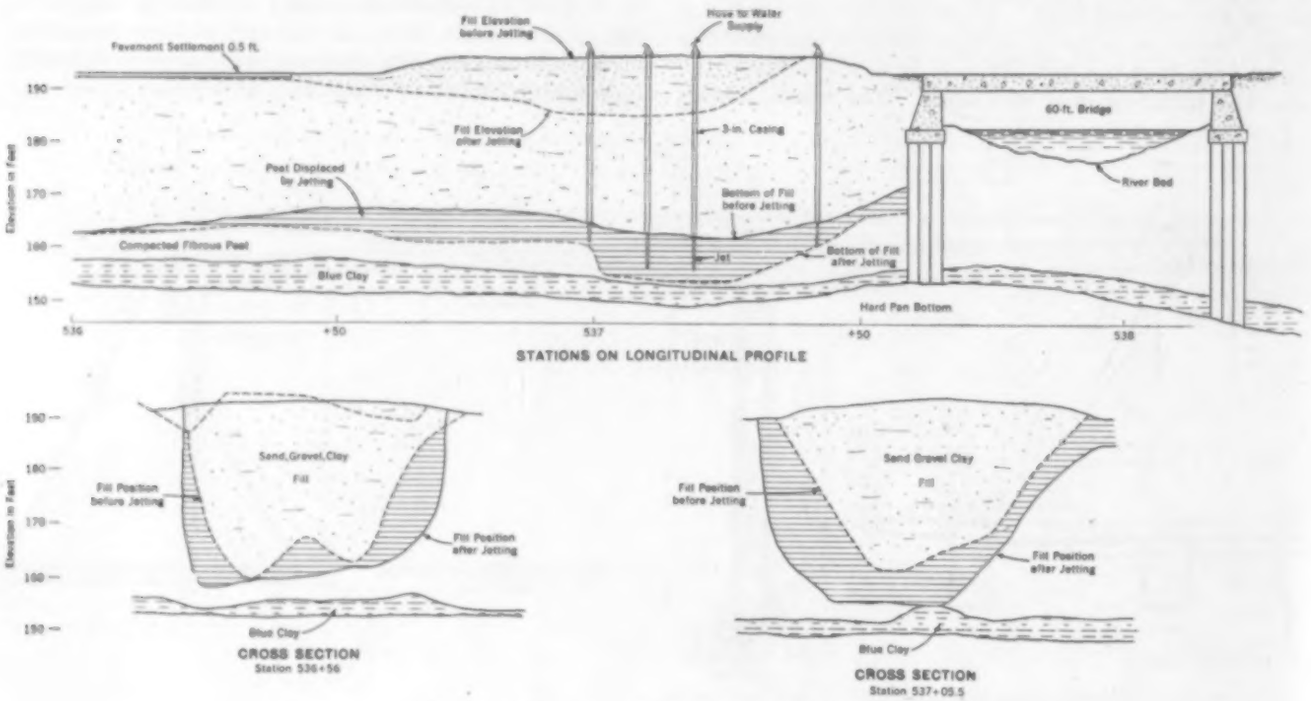


FIG. 1. DISPLACEMENT OF PEAT BY JETTING

springs, or in which water was held up in the frost area by an impervious layer of soil below. Such heaves can be prevented by a proper and intelligent design of tile drainage.

On the other hand, heaves which occur in silts and in some clays are the result of a capillary phenomenon and cannot be corrected by tile drainage. The matter of treatment of the frost boil on our non-rigid surfaces presents a somewhat different problem. The use of tile drainage may not prevent the upheaval, but when

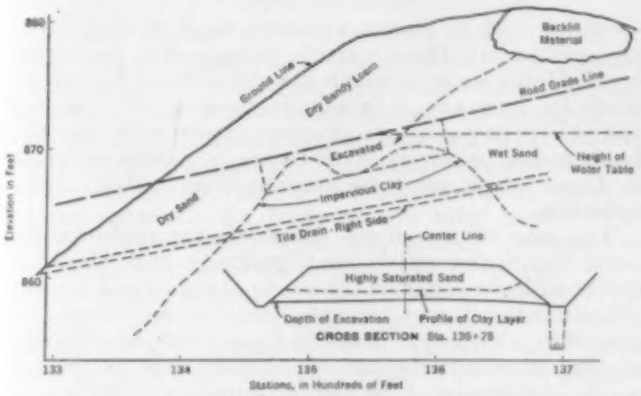


FIG. 2. EXAMPLE OF SUBGRADE DESIGN IN BRONSON SANDY LOAM

water is liberated during thaws it is carried away by the drains and the condition alleviated.

It is not so much a question of the soil material itself as of an abrupt change between a finer and coarser material. The finer material necessarily draws water from the coarser material through capillarity, and that is true throughout the whole range of soil textures; clay draws moisture from silt, and silt draws moisture from sand. So frost heaving will occur in fills if silt or extremely fine sand is encountered in a cut and no account is taken of where the material is placed in the fill.

Our field studies have indicated definitely that trouble from frost action invariably occurs wherever silty or very fine sandy silt textures prevail. As the laboratory investigations to date have not revealed a method of treatment to prevent heaving in these materials, they are actually removed from the grade on new construction work. In Michigan, we do not feel that it is necessary to import material for backfilling. A number of serious heaves on important trunk lines have been corrected simply by removing the undesirable soils and backfilling with a sandy loam obtained from the cut in question above the level of the undesirable material. During the winter an upheaval of the shoulders on both sides of the pavement at these locations can actually be seen, while the road surface itself remains in its true position. On new pavements built during 1930 a great number of silt deposits were removed and backfilled with sandy materials obtained close at hand, and without an exception heaving was eliminated.

The conditions shown in Fig. 2 are typical of many localities where special design measures are necessary to insure proper drainage of the subgrade. It seemed advisable, in this case, first to level off the outcropping clay layer so that no pockets of undrained sand existed within the limits of frost penetration, and then to tap the sand layer above the clay barrier with a line of 6-in. tile. When this was accomplished, the water table dropped and the cut became perfectly dry.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Latin-American Syndicate Defended

SIR: The numerous comments following my letter on a "Latin-American Engineering and Construction Enterprise," in the November 1931 issue, call for a brief reply. In all, 42 discussions were submitted, 10 of which came to me privately; 22 were decidedly in favor of the project, 9 just as decidedly opposed, and 11 either neutral or non-committal. Answering the objections raised I would state:

1. If any jealousy toward our engineers exists among the Latin-American technologists, it will have to be overcome by tact, good humor, and patience.

2. The great foreign debts that might some day be repudiated do not constitute a logical reason for our capitalists to refuse absolutely, for all time, to lend money to Latin Americans. If we do so, they will certainly turn to Europe in order to transact business.

3. The instability of Latin-American governments is truly a serious matter, but it ought to be feasible in dealing with them to bind firmly their successors and assigns; and our own government should use at least its moral influence to protect its citizens against loss through revolutions and changes of authority.

4. The existing over-plus of materials would soon be absorbed, were satisfactory trade relations once established—as they would be by a successful functioning of the syndicate.

5. Confidence in the *bona fides* of the syndicate and its members would soon become firmly established by their operation on strictly ethical lines—a *sine qua non* for the entire project.

6. No matter how low may be the present values of old investments in Latin America, development will continue, and will have to be carried on by means of outside capital; hence if our capitalists desire to share in the profits, it will be necessary for them to forget much and to promote a general spirit of optimism concerning foreign business affairs.

7. There are, and probably there always will be, in Latin America a fair number of enterprises sufficiently sound to warrant financing. To a reasonable extent they should remunerate their promoters and the buyers of the securities, provided the enterprise is cautiously handled along truly economic lines.

8. It is inevitable that at first the operations of the syndicate would militate against the interests of a few American contracting companies that operate abroad

Such companies, of course, should join the syndicate, and should not attempt to block a patriotic undertaking for purely selfish reasons.

9. The members of the syndicate would have to be composed of "broad-gaged" men who would prevent the starting of any internal strife that would endanger the stablility of the organization.

The positive advantages to be gained by the establishment and effective operation of the suggested syndicate include:

1. Bringing the Latin Americans into closer touch and harmony with our people.
2. Providing our southern neighbors with the numerous comforts and conveniences of modern life.
3. Securing trade and thus establishing prosperity for our country.
4. Obtaining work for American engineers and contractors that would otherwise probably go to those of their European competitors.
5. Procuring safe and profitable investments for American bankers and the buyers of the securities they issue.

The large amount of adverse comment clearly indicates that, in spite of the fact that the present is undoubtedly the logical time to inaugurate the project, any such attempt in the near future would result in failure. Yet in my opinion, the time will surely come, sooner or later, when the American business men will find it necessary to secure the trade of Latin America, and when our engineers, our contractors, and our bankers will conclude that joint action by all three of these groups is essential for our national well being.

J. A. L. WADDELL, M. Am. Soc. C.E.
Waddell and Hardesty, Consulting Engineers

New York, N.Y.
April 8, 1932

Progress During One Lifetime

SIR: A man, John R. Voorhis, recently died in New York City at the age of 102 years.

When he was born, that city contained only 203,000 inhabitants. It was not until the year he was born that railroads became a practical success, with only about 40 miles of trackage in existence in the United States. When he was 7 years old the largest locomotive weighed 12 tons; when he was 8 years old the first ship operated wholly by steam crossed the Atlantic Ocean. About this time the first railroad tunnel in this country was built and, although there were a few chain-cable highway bridges, the iron bridge era did not begin until the boy was 10 years old.

All the wonderful changes now familiar to us in methods of transporation and means of communication have taken place in the lifetime of this one man; all the great railroads, all the great bridges, all the telegraph lines, all the great steamships, all the great power developments, hydraulic and electrical, and of course the automobile, the airplane, and the radio—all in the span of one human life.

Last year there were 79,000 students of engineering in the engineering schools of the United States, but less than half a dozen such institutions were established before the end of the Civil War, and most of these were schools of science rather than schools of science and engineering. There had been only 380 graduates, up to that time, in the best known of these schools, and there were probably not more than double this number of engineering graduates in all of them combined by the time this man was 34 years old.

I think this makes us realize, perhaps more than in any other way, what tremendous changes have taken place in methods of living and in varied opportunities for intellectual development during this short period of the world's history—the life of a single man.

PALMER C. RICKETTS, Hon. M. Am. Soc. C.E.
President, Rensselaer Polytechnic Institute

Troy, N.Y.
March 27, 1932

Tax Valuation Often Misunderstood

SIR: I wish to discuss a point in connection with the foreword to Mr. Black's article on valuation procedure, in the March issue, in which it is stated that "Valuations made for purposes of taxing, exchanging, or financing non-utility property are of great importance, but the fundamental principles involved are in general the same as those which must be considered in public utility valuation."

This may be true if the valuations are made for the same identical purpose, but generally they are not. Public utility valuations are nearly always made for rate adjustments. Every business whose output is used by the public is a utility. But only those which, for economic reasons, are essential monopolies require that the rates of service be regulated by public authority. The others, being open to free competition, require no valuations for rate purposes.

I hold that the meaning of "value" is indefinite unless a modifier accompanies the word, and that "value" applied to taxation is different from "value" considered as a rate base. On page 175 Mr. Black states exactly my views on the subject of rate-making valuation when he says, "The fundamental theory of rate making is that a utility is entitled to a return of every dollar honestly and prudently invested in facilities for providing service to the public."

Although I hold that annual taxation on capital property is outrageous, it is a commonly accepted practice. It is a common usage to take a percentage of, say, from 60 to 80 per cent of what the property would sell for. In other words, this represents exchange value. A rate base should be derived from investment costs, and a tax base from a study of the income account. The latter has no reference to costs in reproduction.

J. P. SNOW, M. Am. Soc. C.E.
Consulting Engineer

Boston, Mass.
March 15, 1932

Cause of Sludge Bulking

SIR: In the March issue, Mr. Donaldson has presented a valuable résumé of the activated sludge process for treating sewage. He suggests caution in applying operation procedure and design data of one plant to the problems in another. That is a most valuable suggestion. We are very apt to be misled by trying to apply data which may be fully applicable under certain conditions, to problems where the conditions may be entirely different.

Regarding the filamentous growths as an immediate cause of sludge bulking, I think possibly the emphasis should be placed on the word "immediate" because the author also points out what seems to me to be an important underlying and fundamental cause—that is, the passage or leakage of organic matter through the aeration tanks. In other forms of sewage treatment the filamentous growths develop very rapidly where there is

organic matter going directly through the process. Perhaps there lies the root of the problem. Possibly the filamentous growths, although the immediate cause of the bulking, might be considered as a result rather than the fundamental cause of the difficulty.

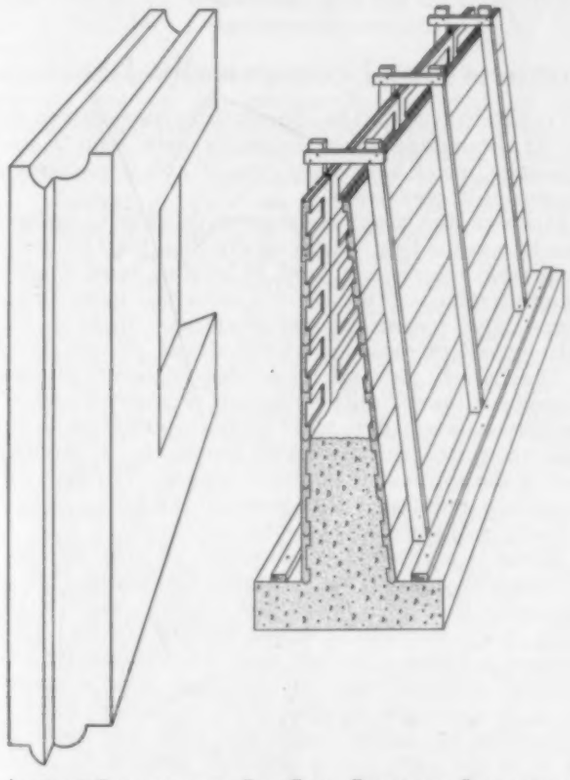
HARRISON P. EDDY, M. Am. Soc. C.E.
Metcalf and Eddy

Boston, Mass.
April 9, 1932

Concrete Must Be Protected from Sea Water

TO THE EDITOR: The interesting article by G. F. Nicholson on "Protecting Reinforced Concrete Against Deterioration by Sea Water," in the November issue, and his paper read before the International Congress of Navigation in Venice, Italy, in September 1930, on the same subject are of great value to the profession. Also of value is the Report to the National Research Council of Messrs. Atwood and Johnson, and their paper, "The Disintegration of Cement in Sea Water," published in the TRANSACTIONS of the Society, Vol. 87 (1924).

Many eminent engineers have written extensively on the subject of disintegration of concrete by sea water, alkalis, and sewer gases, but few have had the opportunity to study the excellent results obtained by the impregnation of concrete with asphalt as a resistant to sea water.



ASPHALT IMPREGNATED PRE-CAST CONCRETE SLABS FOR FORM LUMBER
Vertical and Horizontal Joints Filled with Hot Asphalt

Marine structures built with concrete so treated have been standing in Los Angeles Harbor for ten years, and a recent inspection showed that there was no sign of deterioration, because the pores of the concrete were absolutely sealed against moisture.

From my examination of a great many concrete structures built in sea water from San Diego, Calif., to Vancouver, B.C., I am convinced of the necessity for protecting all portland cement concrete if it is exposed to sea water or sea air. If reinforced concrete bridges are to be built where sea air can attack the concrete, it should also be protected.

The protection of such structures can be accomplished by the use of a pre-cast concrete slab impregnated with asphalt. The slab has a mechanical key on the inside into which the concrete is poured. The joints are specially designed to receive hot asphalt, making them waterproof. The slab has the advantage of saving in the sheeting of the forms, in the oiling, and handling of the sheeting, and in the patching or guniting. These slabs can be used for bridges, bridge piers, sea walls, or dams. The slabs are made in a size convenient for handling.

J. W. B. BLACKMAN, M. Am. Soc. C.E.
President, Pan-Pacific Piling and Construction Company

Wilmington, Calif.
March 19, 1932

Newton's Theorem Restated

DEAR SIR: Professor Howland's suggestion for "Laying Out a Circular Curve with Tapes," which appeared in the January number, is very interesting, and it is surprising that the relation to which he calls attention is not better known.

I am not familiar with Sir Isaac Newton's proof of this theorem, but have found it readily susceptible to proof both by geometric and trigonometric methods. I would suggest, however, that in order to bring out its significance more fully the theorem be stated somewhat more specifically as follows:

"The ratio of (1) the distance from any point on a circle to the middle point of any chord of the circle to (2) the distance from the point to the intersection of the tangents drawn at the extremities of the chord, is constant for all points on the circle; and is equal to the cosine of one-half the angle of intersection of the tangents."

A number of formulas can be written around this relation for use with various combinations of known conditions. It should be useful not only in the field but in the drafting room as well.

SHELDON K. BAKER
Reed and Baker, Consulting Engineers

Phoenix, Ariz.
March 12, 1932

An Interesting Structure

DEAR SIR: The Ledyard Bridge across the Connecticut River, so well illustrated in the fore part of your April issue, has an especial appeal to me. As I came to Hanover only eleven years after the bridge was built in 1859, and have traveled over it during the sixty-odd years since, I have gleaned much about its history.

The site of this bridge is such that its antecedents are worthy of notice. Only eleven years after Col. Enoch Hale built the first bridge over the Connecticut River at Bellows Falls, one Rufus Graves built the second bridge at Hanover. One of the early "turnpikes" had been built to connect the college with southeastern New Hampshire and Boston; and the bridge was an important link for the trade connection of northern Vermont with Boston. Graves' Bridge was reported to consist of a single span of 236 ft. arched in form; but just how it was constructed is not known. Some of the timbers used were said to have been 60 ft. long and hewed 12 in. square. The builder is

reported to have first made a model to gain subscribers to the project for the toll bridge. But report says it fell by its own weight after eight years (1796–1804). And for many years after that, transportation across the river was by ferry.

The Ledyard Bridge joins the town of Hanover, N. H., with Norwich, Vt., and its history is interwoven with that of Dartmouth College. It was the first toll-free bridge over the Connecticut River. Since the railroad is on the Vermont side of the river, the bridge has been constantly subjected to the heavy freight traffic serving the college, with coal, lumber, machinery, and similar goods. It has two spans of a little less than 200 ft., each continuous over a center pier.

Until 1913 it served without arches, but continued increase of heavy teaming had then brought it to a precarious condition. On consultation with the selectment of the town, I designed reinforcement of the chords by added timbers, larger bolts, and strengthening of the joint splices. This work sufficed for a period of fifteen years. Then, in 1927, decay of some timbers near the ends was discovered, and the increased weight of trucks and their loads raised the question of choosing between radical reinforcement of this bridge or a new structure. J. P. Snow, M. Am. Soc. C.E., was then consulted, and timber arches were inserted with the hope of adding another 15 or 20 years to the life of the bridge. This treatment has proved to be adequate thus far.

The bridge was built by a local contractor for a contract price of $6,000, as shown by town records. It is named from the world traveler, Ledyard, a student of Dartmouth in the early years of the college, who was seized with the wanderlust, left college after one year, wandered over the world, and accompanied Captain Cook in the famous voyage in which the latter lost his life.

These few notes may supplement the brief statement given with the photograph. Not so very long ago poets glorified, in flowing verse, the old oaken bucket and the old arm chair. Surely the old covered bridge, which has the affectionate regard of many of the multitude which has traversed it, deserves a Tennyson to write in harmonious rhyme a tribute worthy of it.

ROBERT FLETCHER, M. Am. Soc. C.E.
Director Emeritus, Thayer School of Civil Engineering, Dartmouth College

Hanover, N.H.
April 8, 1932

It is to be noted that credit should have been given Professor Fletcher for courtesy in providing the original from which the cut in the April issue was made.

Comparisons to Include All Costs

TO THE EDITOR: I have read with a great deal of interest, in your February issue, the article by F. H. Frankland on the comparative costs of tunnels and bridges. This reminds me of the old controversies as to the values of different gages for railways. An extensive study which I made a good many years ago of the literature of the days of the "battle of the gages" showed the same fallacy of taking a broad-gage railway in one place and a narrow-gage railway in another place and proving conclusively, according to the selection made, that broad gage or standard gage or narrow gage, depending on the predilection of the writer, was the most desirable.

There is only one reasonable basis for the comparison of the economic value of a bridge or a tunnel, if there is any chance for doubt as to which should be used, and that is to design both for the expected conditions to be met at the particular point under consideration. "Expected conditions" of course implies reasonable consideration for the future and reasonable estimates of future traffic.

The estimates of cost must cover not only the cost of the actual structure but also the cost of the approaches and necessarily include land damages.

The costs of maintenance and operation of both structures must then be estimated and duly capitalized and further allowance made for differences in costs of operation of the vehicles carrying the expected traffic—that is, cost due to differences in length of route, rise and fall, etc. As an example of these methods of comparison, I may refer to my paper, "Highways as Elements in Transportation," in the TRANSACTIONS of the Society, Vol. 95 (1931), page 1038.

The matter of the concentration of large volumes of traffic in congested areas due to unduly large bridges is one which must be given very careful consideration—a consideration often involving heavy expenditures for approaches. This again emphasizes the need of a complete study of all the factors entering into the project and not merely a comparison of the relative cost per lane of the main structure itself.

F. LAVIS, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
April 6, 1932

Tunnels Not Economically Justifiable

TO THE EDITOR: The illuminating comparisons made by Mr. Frankland in the February issue tend to clarify a question which has caused considerable speculation and discussion in past years.

Much of the argument against high-level bridges is based upon the long, costly approaches, required because navigation interests, instead of limiting mast-heights or adopting relatively inexpensive telescopic units for ocean liners, have forced vertical clearances up to a height entirely out of reason. At the recent Annual Meeting of the Society, several prominent engineers effectively argued for lower limits on bridge clearances, and asked navigation interests to meet bridge interests on an equitable basis. If their case wins the success it merits, the cost of the approaches on future high-level bridges will be materially reduced. The economy of a bridge as against a tunnel will then be even more apparent.

There is another way, however, of treating the approaches, in order to make the case for bridges even more favorable than Mr. Frankland's figures show it to be. This is by the use of spiral approaches for highway bridges. This is a feature that was evolved by J. A. L. Waddell and proposed by him upon several occasions. It is a structural possibility that merits more consideration by bridge engineers than has been given to it in the past. It is perfectly feasible to construct double-screw spirals that separate entirely the incoming and the outgoing traffic, thus eliminating any possibility of their interference with each other. These spirals can be made of such large diameter that the curvature of the roadway will give no appreciable difficulty to vehicle drivers. Anyone who has driven up or down the tortuous approaches leading from Riverside Drive to the George Washington Bridge need have no fear of a spiral approach.

A large saving in right-of-way costs would be effected in most cases by the use of this expedient. It is certainly

well worth investigating for any high-level highway bridge over a stream which traverses metropolitan areas. The approaches could be concentrated in an area covering one or two city blocks. They would be easily accessible from all directions. Moreover, they could be housed in attractive structures having a large rental space available for producing additional revenue.

The Holland Tunnel cost $14,000,000 per roadway lane, not including capitalized annual charges for ventilation and maintenance—charges which have proved unusually large. A bridge can be built across the Hudson River at 57th Street, or at some intermediate location, for $7,000,000 per roadway lane. There will be no ventilation charge and the maintenance cost will be relatively small.

In view of these figures, what economic justification is there for a tunnel at 38th Street?

HAROLD E. WESSMAN, Assoc. M. Am. Soc. C.E.
Waddell and Hardesty, Consulting Engineers
New York, N.Y.
March 27, 1932

Steel or Concrete for Long Spans

TO THE EDITOR: Among the excellent articles published in the February issue are two of special interest to bridge engineers: one is "Tunnels or Bridges—Which?" by F. H. Frankland, and the other is "Concrete Arches for Long-Span Construction," by E. Freyssinet.

Reinforced concrete of a possible ultimate strength of 70,000 lb. per sq. in., confidently predicted by M. Freyssinet, could very well compete with steel for use in very long spans. It possesses the additional advantage of having almost no maintenance cost, as concrete requires no painting. Concrete arches of that kind would offer formidable competition against tunnels wherever the question of bridge versus tunnel might come up.

It was in London, a hundred years ago, that this question first arose, when it was decided to build the first submarine tunnel under the Thames. This tunnel was built by Brunel for foot passengers, and in 1825 was enlarged for railroad traffic. About the same time, two of the first long-span suspension bridges were built—Telford's chain bridge over Menai Strait (1824) and Chaley's wire-cable bridge in Freiburg, Switzerland (1832), both for highways.

The suspension bridge for heavy railroad traffic came later. The first one, which was built by Roebling over the Niagara River in 1855, was 800 ft. in length—the longest railroad span at that time. It proved to have insufficient stiffness under heavy railroad trains and was replaced by a steel arch bridge in 1897. The unsatisfactory experience with this bridge prejudiced engineers against the suspension type for heavy railroad traffic, so that for the Firth of Forth Bridge and the Quebec Bridge, each with spans of 1,700 ft., the cantilever type was chosen. The Brooklyn suspension bridge, with a span of 1,600 ft., carries two railroad tracks, but only for rapid transit lines.

The prejudice against the suspension type for railroad use has vanished in the light of advanced theoretical knowledge, and its suitability and economy for heavy railroad traffic on multiple tracks—as for the proposed Hudson River Bridge at 57th Street, New York—is no longer questioned. To the fact stated in Mr. Frankland's paper that, other things being equal, long-span steel bridges are cheaper than submarine tunnels, must now be added the proposition of M. Freyssinet that concrete arches of very long span may economically compete with steel bridges under certain conditions.

That the arch type is cheaper than the suspension or cantilever type when the banks permit inexpensive abutments, has been demonstrated by construction of long-span steel arches at Hell Gate, New York City; Bayonne, N.J.; and Sydney, Australia. The three bridges compare as follows:

Bridge	Span Between Skew-Backs	Load per Linear Ft.		Span Steel in Tons
		Dead Load	Live Load	
Hell Gate	995 ft.	51,000 lb.	24,000 lb.	19,000
Bayonne	1,675 ft.	28,000 lb.	7,000 lb.	18,000
Sydney	1,665 ft.	42,000 lb.	12,000 lb.	29,000

In 1894 a steel arch of over 3,000 ft.—twice the span of the Sydney Harbor Bridge—was proposed by the English engineer, Max Am Ende, for bridging the Hudson River at lower Manhattan. He did not know, however, that the span would have to be at least 5,500 ft. between abutments on rock and that there could be no intermediary support for its erection because of excessive depth to rock between banks and because of the denseness of the river traffic.

There are locations like the Golden Gate at San Francisco where the question of tunnel or bridge does not come up; very deep water and rocky shores decide against the use of a tunnel. At that location a concrete arch with a span of from 4,500 to 5,000 ft. would form a magnificent portal, assuming that concrete with an ultimate strength of 70,000 lb. per sq. in. could be had, as expected by M. Freyssinet, and that it could be placed from a suspension bridge first built for that purpose. This last consideration alone would make such a proposition somewhat fantastic, not to mention the fact that a concrete arch is out of the question in an earthquake country. A steel arch bridge would be feasible, but all facts point to a suspension bridge as the safer solution on this earthquake location.

GUSTAVE LINDENTHAL, Hon. M. Am. Soc. C.E.
Consulting Engineer
Jersey City, N.J.
March 17, 1932

Action of Soil Arch Important

DEAR SIR: In his paper on the "Design of Tunneled Sewers in Unstable Ground," in the April issue, Mr. Hennes makes two statements that should not go unchallenged. On page 247, he states: "So long as there continues to be uncertainty as to the ultimate durability of the soil arch and as to the degree of protection afforded by it, the engineer is safer in discarding this arch as an effective factor in sewer design"; and further, in another paragraph on the same page: "If we are prepared to accept as the required loading a uniform vertical pressure equal to the weight of the superincumbent soil . . . ."

Each of these statements is definitely misleading and, in my judgment, not founded on fact. If such conditions existed, tunnel operations could not be carried on at any considerable depth even in normally dry soil. It is suggested that Mr. Hennes make the sand-arch experiments described in my paper No. 1174, "Pressure Resistance and Stability of Earth," given before the Society on May 18, 1910, or better still, that he conduct the old English experiment of taking, say, a 3-in. pipe 2 ft. long and tying over the end a piece of muslin or paper just strong enough to hold the sand in place. If he will then put a foot of dry sand in the pipe, he will find that he cannot dislodge the sand by any pressure, within

the limits of practicability, exerted on a loose-fitting piston bearing on the sand. And he will find if he pursues his investigation further, that because of this arching action, he cannot get on any normally dry soils a greater pressure relatively than he can get in small experiments with clean dry (hour-glass) sand.

If his soils are pliable clay or quicksand, then he must design for hydrostatic conditions. In such cases, he should design his sewer with haunches because, if the ground is so soft that it can be displaced at the sides by pressure from the top, it may also tend to roll under eccentric loading, even if the construction ring is of a so-called "self-contained" design.

An interesting phase of this subject was noted on the old Battery Tunnel under Joralemon Street, Brooklyn, in 1906–1907. As the shield advanced, the pressure at the top, largely through impact, pressed the cast-iron lining out at the sides, breaking the cast-iron rings at the crown and flattening them down as much as 7 in. And yet, when lateral stability was reached, the cracked plates sustained the arch load without further settlement. It is true that vertical posts were set up at intervals, but I saw many cases where these were removed without damage. Later on, under my supervision, long sections of this roof were cut out in 4 by 10-ft. pieces, after being shored up and braced, and were jacked up 30 in. vertically by the simple process of "bleeding out" small volumes of sand as the jacking proceeded. A 16-in. ring of brickwork was then built under the sections jacked up, thus forming a new roof 14 in. higher at the intrados than the one which had flattened. At no time during all these operations was there any evidence of other than normal pressure over the exposed or intermediate section.

J. C. MEEM, M. Am. Soc. C.E.
Consulting Engineer

Brooklyn, N.Y.
April 4, 1932

Students Should Have Inspiring Work

DEAR SIR: The paper by Professor Finch on the "Place of Surveying in Engineering Education," in the March issue, exemplifies the problems that are current in engineering education today. The point made most frequently is that the civil engineer of this generation does not have as much practical use for surveying as did his predecessors. Therefore, the amount of surveying in the curriculum should be reduced to the minimum that is sufficient to acquaint the student with the rudiments of the science. However, it seems difficult to determine the proper or optimum number of semester hours.

As Professor Finch points out, little attention is given to the teaching of surveying. In this respect teaching methods are weak. Because surveying is the beginning of most civil engineering undertakings, it is particularly useful in orienting and motivating the students. What young man can resist the imaginative appeal that is uppermost in the surveys for a railroad, dam, bridge, or any other structure! The instructor who uses these influences wisely is developing in his students major interests that will endure.

It is my belief that surveying should be taught on the project basis from the beginning. If the ultimate objective is the training of engineers and not technicians, the problem put before the student should be something that he will recognize as real and similar to what he may meet later. Some instructors feel that, in the beginning, it is advantageous and desirable to focus attention on instrumental manipulation, through exercises which the student follows like recipes in a cook book. I believe, however, that more effective progress will be made in developing creative and reasoning ability and judgment, if the student is given an engineering project in which the objective is something more than instrumental skill, important as that is. He will learn the instrumental manipulations as he goes along.

L. O. STEWART, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering
Iowa State College

Ames, Iowa
April 8, 1932

Two Items in Highway Work

DEAR EDITOR: Two elements of Mr. Bauer's paper in the March issue deserve comment: (1) How dry was the "fairly dry" reinforced concrete slab? and (2) what is a comparable unit for right-of-way purchases?

In the decade before 1900, the vigorous use of 6 to 20-lb. rammers was specified. Sometimes the most violent ramming failed to bring any appearance of dampness to the surface of the mass. The dam at Trenton Falls, N.Y., was an example of this kind of concrete.

In the decade after 1900, rammers were thrown away and the ingredients were "hydraulicked" into the forms on the theory that water not needed for crystallization of the cement would rise to the surface and run off. As a result one reinforced concrete dock in the Brooklyn Navy Yard needed repairs in three years.

Another pier, after 30 years of service, needed repairs to less than 4 per cent of the surface of the main concrete side walls. What made one pier last so well? Built in 1901, it extended 550 ft. into the East River, and was subjected continually to sewage, chemicals, and foul matter from the Wallabout Channel. The mechanical wear of ice, as well as its freezing and thawing action, was very severe. At that time dry mixing was the fad. On this pier the concrete took only a few light blows of the rammer to become a jelly-like, quaking, plastic mass. Repairs to 4 per cent of the side-wall surface were made in the fall of 1931.

The extent of these repairs affords some measure of the action of sea water, plus wave action from ferry boat swells, on mass concrete with a "quaking" dense mixture.

The outstanding difference between the concrete in this pier, the very dry material in the quay walls which preceded it, and the "hydraulically" spouted concrete which followed it, was in degree of wetness. The value of real control by continual inspection of results, before the term "water-cement ratio" was used, is seen by the small amount of repairs required by the pier after 30 years of service. My guess as to the "slump" is that it was between 2 and 3 in. in a 12-in. cone. Stated tersely, the "drys" were too dry, and the "wets" were too wet. "Just-right" results in concrete, as in government, depend on the amount of time, trouble, money, and conscientious effort expended by those responsible for the work.

Concerning right-of-way—costs in dollars per acre or per square foot give no basis for comparison between different localities. The only practical unit known to me is the ratio, or the multiplier, between the assessed valuation and the final purchase price.

Some seven years ago a report was required on the estimated cost to the Federal Government of some farm property proposed to be condemned. The experience of

the New York, New Haven, and Hartford Railroad in obtaining right-of-way was very helpful indeed, for it was an old railroad in a well settled, stabilized territory. In Connecticut, this railroad expected to pay $1^1/_8$ times the assessed valuation for city property, and 3 times the assessed valuation for property in the country. This proves that condemnation commissioners from the city are less liberal minded than those living in the country, in the ratio of $1:2^1/_4$.

L. F. BELLINGER, M. Am. Soc. C.E.

Atlanta, Ga.
April 7, 1932

Placing Underground Utilities

TO THE EDITOR: The idea of formulating definite plans for the location of utility structures under streets and highways in order that the construction of these services may be carried out on an orderly basis, as discussed in Mr. Consoer's paper in the March issue, is one which has long appeared attractive. It has, in fact, engaged the sympathetic consideration of the various utilities, both individually and collectively, for a number of years, advance planning being considered essential to public convenience, economy, and service.

Where present use of subsurface space is limited, much can be done in the way of definitely allocating space to the various utilities in such a way as best to meet the requirements of the public. There are in Mr. Consoer's paper, however, a few points of major importance which appear to require further consideration in formulating a correlated plan of construction.

The locations recommended for the various utilities, as shown in Fig. 1 of Mr. Consoer's paper, are placed at approximately the same distance from the center line of the pavement regardless of the ultimate width of the highway. In the 80 and 100-ft rights-of-way, it would seem more practicable to define the location of the conduit with respect to the curb and retain its position at about the same distance from the curb as that shown for the 66-ft. right-of-way. This would keep the conduit and manhole outside the pavement for a considerable period, and in all cases would avoid the inconvenience to motor traffic of having the manhole openings located near the center of the ultimate pavement.

Studies of specific instances of providing tunnels along the highway for housing jointly the plants of the various utilities have led to the conclusion that the plan is generally impracticable. This is largely because of the difficulty of making service connections to the tunnel for the several utilities without creating undesirable and even hazardous conditions in the tunnel. Further, the inclusion of both power cables and gas in the same tunnel introduces the hazard of severe gas explosions, such as the one experienced in London about two years ago. The presence of power cables themselves involves, of course, the same hazard to the employees of the other utility companies that Mr. Consoer recognizes as applying to manholes used jointly by the telephone and power companies.

Recommendation is made that telephone or power subways be constructed with sufficient ducts to care for a period of at least fifteen years. Although it is desirable to plan for even a longer period than 15 years, it would often be uneconomical to provide initial facilities for such a long period.

It is suggested that the installation of transverse service pipes opposite vacant property should not be permitted until the street is scheduled for paving. But it sometimes happens that a real estate development warrants the provision of service connections from the main conduit to each block, whether built upon or vacant, in order that the construction work and necessary trenching in the street may all be done at the same time. It would seem that, aside from the economics of the case, such treatment is desirable from the viewpoint of the public in that street excavations and their attendant disturbance to vehicular traffic are reduced to a minimum.

The suggestion is also made that all connections of utilities to vacant lots be made approximately at the middle of each lot. Actually it is a frequent practice in residential districts to make telephone and electric service connections to the block at one point, the distribution to the individual lots or buildings being made from the rear property line. Where this is practicable, the obvious advantage is that only one trenching operation is required to install the service connections for the entire block.

In planning a coordinated arrangement of the underground structures in streets already extensively occupied, it has been found that such considerations as the existing subsurface structures, coupled with demands for service in particular localities, so completely governed the specific arrangements as to make it difficult to follow any set plan of relative location of the several utilities. For this reason it would appear that the establishment of broad basic principles would best serve community interests both from the standpoint of the city authorities and of the utilities themselves.

WILLIAM H. HARRISON
Plant Engineer, American Telephone and Telegraph Company

New York, N.Y.
April 1, 1932

Planning Underground Utilities

TO THE EDITOR: The viewpoint presented by Mr. Consoer in his article, "Location of Underground Utilities," in the March issue is distinctly that of an engineer engaged in paving and interested primarily in keeping streets from being torn up in the location of public utilities.

Throughout the recent period of rapid industrial growth of our cities, nothing has been allowed to stand in the way of the development of underground facilities. Those responsible for construction of the highways have had to see their work destroyed by these service installations. In fact, there is room for honest doubt as to whether a street actually constitutes a traffic way or only a site for pipes. Certainly it is high time for intelligent planning in the matter of street layouts and for a new allocation of street uses.

Perhaps this is the proper time to establish a new system. The rush of urban development is for the present over. Water supply and various utility services, which for a generation have been a step behind the demand, have now caught up with it. As Mr. Consoer has suggested, utility management is, for the first time, probably in a position to consider future requirements and to lay out an ultimate plan of pipes or conduits, as the case may be, to meet the demands of the next ten or fifteen years. It would be a great achievement if this article were to stimulate a wide study of the situation from an economic viewpoint and the establishment of new standards of practice that would eliminate not only the waste resulting from the hasty design of underground utilities, but also destruction of the pavement.

The plan, suggested by Mr. Consoer, of placing the utility service between the property line and the curb, or

entirely out from under paved areas, is one that most city engineers have, at one time or another, tried to work out. I can recall convincing subdividers of the propriety of such a plan, only to have my work vetoed by my colleagues of the water-works service who have almost invariably been opposed to the duplication of the mains.

Of recent years I have noticed a greater leniency in this respect on the part of those who install both gas and water works. This, however, may be partly due to experience with the superior grade of pavement now being laid and the consequent increased cost of removal and replacement of this pavement, and by the growing demand for newer standards of trench backfill. I would like to see it become a national policy to place water and gas mains behind the curb or sometimes in alleys, where they are available, as there is no doubt that by far the greatest yardage of pavement destruction comes from the revision of mains and the installation and replacement of the two types of service referred to. It may be that the younger cities will find it possible to bring about the adoption of such standards, but I doubt if the older ones can.

The question of the location of water conduits, steam and refrigeration lines, and special services has not, in my experience, been of much importance outside the central business districts. In these districts, however, it has become so serious that, in a few years, pipe and wire galleries will probably be installed behind the curb lines. Practically the only alternative would be paving the streets with removable sectional castings, so that the whole street area might in a sense be treated as pipe subway.

The suggestion made by Mr. Consoer for tamped backfills and reinforced or thickened pavements does not seem to be the final answer to the problem. There is good evidence that clay soils cannot be replaced in a finally consolidated condition by any of the means known. Settlement invariably follows such a process, and pavement breakage takes place even after a period of years. The strengthening of the slabs over such trenches merely delays the time of failure. Delayed failures in replaced areas are responsible for many unsatisfactory pavement conditions that are attributed to poor paving design or construction. These failures often do not occur until the fact that a trench was cut through has been forgotten.

I hope that Mr. Consoer's article will stimulate interest in underground planning and in street paving and replacement.

W. W. HORNER, M. Am. Soc. C.E.
Chief Engineer, Sewers and Paving
City of St. Louis

St. Louis, Mo.
April 2, 1932

Guidi's Theorem Misapplied

DEAR SIR: Although Mr. Janni, in his letter in CIVIL ENGINEERING for April, evidently intended to question the principle of reciprocal displacements on which the mechanical method of stress analysis is based, he appears to have a wrong conception of the method himself.

His Fig. 1*a* does not properly represent the condition from which Equation 1 is derived. The end of the arch must be restrained to move only in the direction of the desired reaction, but Mr. Janni is wrong in saying that the necessary restraining forces are not taken into account.

The "well known theorem by Guidi" seems to be misapplied. Figures 1*b* and 1*c* represent different structural systems, between which reciprocal displacement relations would not exist unless there were additional restraint conditions. Mr. Janni describes Fig. 1*b* as representing an arch with a free end acted upon by an unknown force. Unless this force is so directed as to make the point B move in a horizontal direction, Formula 2 is not correct. This condition is not stated.

Figure 1*c* represents an arch which is fixed at the left end and hinged at the right end. Equations 2 and 3 apply to such an arch and evidently prove nothing in regard to an arch fixed at both ends.

In spite of Mr. Janni's statement that the ellipse of elasticity "shows the error of this theory in a still more glaring way," which he offers without explanation, there is nothing inconsistent between the two theories. The theory on which the mechanical determination of reactions is based is so well known that no explanation of it is necessary.

CHARLES S. WHITNEY, M. Am. Soc. C.E.
Consulting Engineer

Milwaukee, Wis.
April 8, 1932

Reciprocal Deflection Theory Correct

DEAR SIR: The letter by Mr. Janni on a "Wrong Conception of a Principle of Elasticity," in the April number, referring to the use of the Maxwell theorem of reciprocal deflection, calls for a rather vigorous denial.

His basic Equation 1, which should properly be stated in the form:

Reaction at B (vertical component of) =

$$\frac{\delta_2}{\delta_1} \times \text{force applied at } C,$$

and in which the direction δ_2 should be measured parallel to the force at C, rather than necessarily vertically, can readily be shown to be theoretically correct. This proof, a copy of which I have filed at Society Headquarters, takes into due account the coexistence of horizontal, vertical, and torsional components of the reaction, both in the real structure and in the model. The horizontal and torsional components fail to appear in the final equation because they do not belong there, not because they have been neglected.

If Equation 1 is true, the issue is now raised as to the accuracy of the conflicting Equation 2. The fallacy here apparently lies in the statement $1 \times \delta' = H' \times \Delta s$, which is an attempt to make a hybrid application of this same theorem of reciprocal deflections, stating in effect that "the deflection at C due to a unit load applied at point B [in the structure shown in Fig. 1*b*] is equal to the deflection at B caused by a unit load applied at point C [in the structure shown in Fig. 1*c*]." These two structures are obviously different in character to such an extent that this statement will not apply. A similar error carries over into the statement that $H' : H = \Delta' s : \Delta s$. These two errors naturally vitiate the succeeding statements made.

The experimental methods recently developed in this country, which hinge upon the application of Mr. Janni's Equation 1, have such an excellent theoretical basis, and have given such satisfactory practical results, that no great fear need be felt as to their accuracy. They have their limitations, but in other directions than that indicated by Mr. Janni.

M. F. SAYRE
Associate Professor, Union College

Schenectady, N.Y.
April 11, 1932

Renaming Streets in City of St. Paul

TO THE EDITOR: The paper by Mr. Schwada on "Street Names and House Numbers," in the March issue, is interesting and instructive. Organized information on this subject is meager; in fact, it can be said that it is impossible to secure.

The opening sentence of Mr. Schwada's paper seems to me very pertinent. Too often the committees assigned to study house numbering and street naming are composed of prejudiced groups whose work reflects their attitude. The engineer, by reason of his training and experience, is impartial and therefore able to handle the situation to the advantage of all concerned.

From time to time, various committees have been appointed in St. Paul to study renaming the streets and renumbering the houses. A recent proposal employed the plan of numbering all the streets, designating the east and west thoroughfares as "avenues" and the north and south thoroughfares as "streets," with the names carrying the double suffix of NE., NW., etc., to indicate the section or quadrant in which the thoroughfare lies. This plan met with considerable opposition in the residential section, particularly from those living on old established thoroughfares such as Lincoln, Goodrich, Fairmount, and Pinehurst avenues, which would become numbered if the plan were adopted. Since this plan was suggested, much study has also been given to the matter of house-numbering systems.

At the outset of making plans, several fundamentals were laid down along the lines suggested in Mr. Schwada's paper. These principles are as follows:

1. Base lines are to follow natural divisions of topography, of street systems, or of sociologically different groups.
2. East and west thoroughfares shall be named, since about 85 per cent of the population reside on these streets. North and south thoroughfares shall be numbered.
3. Section or quadrant suffixes shall be avoided if possible, but directional prefixes are permissible.
4. The block system of numbering is desirable for thoroughfares running in an east and west direction in the outlying districts, and in both directions in the central business district, with the allotment of one number to from 12 to 15 ft. of frontage in the outlying districts and of one number to 10 ft. of frontage in the central business district.
5. The system must be simple and easy to comprehend.

In addition to studying and mapping the many systems proposed, the committees graphically analyzed the numbering and naming systems of fifteen cities. From this study there developed a system which is very similar to that suggested by Mr. Schwada. A report on the application of this system to St. Paul was submitted to the Street Renaming and House Numbering Committee of the Planning Board on October 2, 1931. This plan, which is described in Fig. 1, might be considered more comprehensive than Mr. Schwada's in that the "avenues" are assigned to one side of the base line known as "avenue division"; and "streets" to the other side, known as "street division." A similarity of both divisions is that the named thoroughfares run east and west and the numbered thoroughfares run north and south. Directional prefixes are necessary north and south of an east and west base line, which is at right angles to the base line between divisions. Named thoroughfares in one division are to be designated "avenues" and in their continuation into the other division to be designated "streets."

Incidentally, the western part of St. Paul has a preponderance of avenues and the eastern part a preponderance of streets. Therefore, the assignment of divisions in the plan followed a custom already unconsciously established.

FIG. 1. SUGGESTED PLAN FOR NAMING STREETS IN ST. PAUL

Named thoroughfares are designed to be arranged in alphabetical groups. It may be recalled that Mr. Schwada suggests alphabetically arranged groups of zones. In the proposed system it is essential that the designations "street" and "avenue" may be clearly indicated, as they are the key to the system.

O. H. HOSMER
Assistant Civil Engineer
Division of City Planning
Department of Public Works

St. Paul, Minn.
March 16, 1932

Lightening the Tax Burden

TO THE EDITOR: I have been interested in Mr. Grunsky's comments regarding "The Way to National Progress or Prosperity" in the October issue, and in its subsequent discussion.

It is indeed surprising that many engineers hesitate to apply fundamental principles to the solution of this problem. The fundamental difference between property in land and property in the results of human labor is vital to this discussion, not only from a moral but from an economic standpoint. Taxes upon buildings and any other products of industry tend to discourage their production and limit their consumption. Taxes upon land can have no such effect, as land can be neither produced nor consumed. Taxes upon land discourage the "vacant lot industry" and by reducing the price of the land, make it in effect more plentiful or accessible than it otherwise would be, virtually increasing its availability; but taxes upon the products of human industry have the opposite effect by discouraging production and decreasing consumption.

The idea that the industrial depression is due to overproduction is untenable. The outstanding evil is that millions of our people are out of employment; many of them and their dependents are suffering for the necessities and comforts of life which they would be enjoying if they were employed and could purchase what they need.

The trouble is under-consumption and this is caused by unemployment.

Making land more accessible and removing the taxes upon industry will open avenues for employment, and this in turn will increase consumption by affording the workman the means with which to purchase the goods he desires. It will also greatly simplify government operations, particularly in the matter of taxation. It will better recognize the natural rights to property, for the value of land is produced not by the owner, but by the presence and activity of a community as a whole; and the taxation of land values will be simply taking for community purposes the value that the community produces. This will enable us to abolish taxes upon industry and to leave to capital and labor the full enjoyment of their joint product. It will thus better recognize the natural rights to property which are founded upon the individual's right to that which he produces.

Our paroxysms of industrial depression are so severe and so frequent that they must be prevented. They are not natural, but are caused by laws which divert the results of industry from those who produce them to the pockets of the landlord who, as a landlord, produces nothing.

This problem is so acute and calls so loudly for remedy and prevention, that many superficial thinkers are turning to socialism or communism as the remedy. This tendency is increased by the knowledge that there is no unemployment in Russia, and it is surprising how many of our people, who should know better, are looking to that country as a model to be imitated. The spread of this sentiment is nothing less than a calamity and would result in conditions worse than now exist. The only way successfully to combat this tendency is to correct the condition itself by pointing out the true remedy.

Communism denies all rights to private property. The remedy is not to deny those rights, but to secure and confirm them better than is done at present.

A. P. DAVIS, Past-President Am. Soc. C.E.
Consulting Engineer

Oakland, Calif.
March 15, 1932

Incinerator Construction at Washington

TO THE EDITOR: In connection with Mr. Pearse's report on the status of the art of sanitary engineering, published in the March issue, it may be interesting to note some developments in the construction of incinerators at Washington, D.C. The original specifications were made broad enough to permit any design to be bid upon. At the same time, they were sufficiently restrictive to assure that the design offered by any conforming bidder would be entirely satisfactory, and in so far as possible the materials and features of the plant were specified so as to place the proposals on as nearly uniform a basis as was practical. This involved writing specifications for mechanical stokers, steam generating furnaces, and for furnaces without either of those provisions.

Of the eleven bids received, all but one were from incinerator dealers. The legality of the contract was questioned, and the Comptroller-General of the United States ruled that "the specifications shall be offered in full to the bidder so that the proposals shall be uniform and complete upon the same project and bidders stand upon an equality as to the same with nothing left to the judgment of another in acceptance or rejection in this particular." It was also ruled that matters of design must not be left first to the bidders and then to the awarding officer to decide whether or not the bid conformed to the specifications. As a result of this decision, the engineers prepared detailed designs. These covered such features as the buildings, furnaces, combustion chambers, flues, and chimneys.

When the work was re-advertised, 53 contractors took out plans and specifications, and 24 bids for each of the two plants were received. One plant was designed to handle 425 tons per day, and the other for 170 tons. These incinerators are for that class of municipal refuse which ordinarily is called rubbish—that is, they are not intended for garbage or mixed refuse. The low bids amounted to $321,416 and $169,268, respectively. These prices are equivalent to $756 and $996 per ton of capacity per day.

The Comptroller-General's ruling raises quite definitely the question of the legality of tenders for incinerator plants based on performance guarantees. Obviously, in an engineer's design, plant guarantees cannot be asked for, except in the case of those usually required relative to materials and workmanship.

Both of these incinerators at Washington, D.C., are now under construction and should be in operation during the current year.

HARRISON P. EDDY, JR., M. Am. Soc. C.E.
Consulting Engineer, Metcalf and Eddy

Boston, Mass.
March 8, 1932

Engineering and Poetry

TO THE EDITOR: Mr. McKibben's article, "Bridges and Poetry," in the February issue of CIVIL ENGINEERING, could well be enlarged to take in the whole field of engineering. A man with technical training may at times have an enjoyment peculiarly his own in wandering through the realm of poetry.

That the strength of a structure is the strength of its weakest part is one of the fundamentals of engineering. The ideal structure is one in which all parts are of the same strength. Only one such structure has ever been built and that is "The Deacon's Masterpiece, or The Wonderful One-Hoss Shay" of the poet Holmes. The Deacon built his shay on the principle:

> That the weakes' place must stan' the strain;
> 'n the way t' fix it, uz I maintain,
> Is only jest
> T' make that place as strong as the rest.

Being so built it lasted one hundred years to a day, when it went to pieces

> All at once, and nothing first—
> Just as bubbles do when they burst.

Longfellow wrote:

> Swift of foot was Hiawatha;
> He could shoot an arrow from him,
> And could run forward with such fleetness
> That the arrow fell behind him!
> Strong of arm was Hiawatha;
> He could shoot ten arrows upward,
> Shoot them with such strength and swiftness
> That the tenth had left the bow-string
> Ere the first to earth had fallen!

These lines are quoted by Merriman in his *Elements of Mechanics*, followed by the problem, "Compute the

running speed of Hiawatha in miles per hour, assuming that he could shoot 90 arrows per minute and that, when shooting forward, he aimed at an angle of 45 deg. with the horizontal." The answer given is, "About 46 miles per hour."

Franklin and MacNutt, in their *General Physics*, quote as the oldest English version of the Second Law of Thermodynamics the familiar children's verse:

> Humpty Dumpty sat on a wall.
> Humpty Dumpty had a great fall.
> All the King's horses and all the King's men
> Cannot put Humpty Dumpty together again!

These are only a few of the quotations relating to engineering that might be cited.

ROBINS FLEMING
American Bridge Company

New York, N.Y.
March 11, 1932

Many Uses for the Geodetic Survey

DEAR SIR: The article by Mr. Syme in the March number chronicles a marked advance in the field of surveying and should compel the careful consideration of both officials and citizens, for in this period of general depression it represents a sound economic policy—the spending of money to save money—two factors that are today of the utmost importance and are not, as might be supposed, in opposition to each other.

Although a geodetic control survey will save many times its cost in the planning and construction of a state highway system, such a saving will be by no means the only dividend that the State of North Carolina will receive from its triangulation system now being made by cooperation of the state with the U.S. Coast and Geodetic Survey. When Mr. Syme states that, with geodetic control, a survey is rendered indestructible and that if survey "corners are destroyed they can be easily replaced and the survey can be utilized for many purposes, like the by-products of a factory," he tells a story that in its implications knows no limits save the foresight and resourcefulness of the engineer, and in its possibilities even transcends his imagination.

The various uses to which a geodetic survey may be put are many: The control of hydrographic charts of harbors, bays, and even of oceans; of topographic maps of large and small areas, such as the base topographic map of the United States now being made by the U.S. Geological Survey; of important civil boundaries and of small private ones; and of the correlation and coordination of data required in the study of many scientific problems. Perhaps it will be interesting to note two fairly recent examples illustrating these uses. Although the eastern boundary of the Texas Panhandle is defined as being along the 100th meridian and has been surveyed, at least in part, a number of times, no authoritative definition as to where it was really located on the ground was available until a few years ago. At that time the U.S. Supreme Court appointed a commissioner to determine and mark this boundary, instructing him to "use the most accurate method now known to science and applicable in that locality."

This commissioner, Samuel S. Gannett, of the U.S. Geological Survey, stating that "the method of first-order triangulation unquestionably complies with that specification," made use of the first-order control surveys of the U.S. Coast and Geodetic Survey and determined the boundary from the stations of a first-order arc of triangulation which was extended along the full length of the boundary. Since the boundary monuments thus set are connected directly with the geodetic control survey of the country, they possess that quality of indestructibility to which Mr. Syme refers.

At the other end of the scale, the purchaser of a residence lot in the Montauk subdivision of the eastern end of Long Island sought to be relieved of his obligations on the ground that, since the property contracted for was tied into a triangulation station of the Coast and Geodetic Survey, it had not been satisfactorily described. The Supreme Court of the State of New York, however, held otherwise. Thus the referencing of a cadastral survey to the geodetic survey of the country was given a legal status in this state, a status already fully developed and utilized in Massachusetts and in Hawaii, where land court rules require that such connection shall be made wherever practicable.

It must appear then that among the most valuable potentialities of the geodetic survey now being made for the State of North Carolina by this bureau, is that of tying together in a common system all the property surveys in the state, public and private, large and small, as this will give to the corners of all such surveys a permanence that can be obtained in no other way.

R. S. PATTON, M. Am. Soc. C.E.
Director, U.S. Coast and Geodetic Survey

Washington, D.C.
April 1, 1932

Cooperation Needed in Fact Finding

TO THE EDITOR: The question by Dr. Smith, in his article in the March issue, is fundamental. In connection with it, I wish to call attention to some experience which has been gained in fact finding during the past eighteen years.

As is well known, there are a number of commissions in Washington. These are fact-finding bodies, and not courts. It is their business to assemble facts and to interpret them, but this is often difficult. For twenty-five years, the Interstate Commerce Commission, organized in 1887, was obliged to proceed with its work without having before it all the facts that were needed. Finally Congress authorized the collection of these facts.

It must first be realized that collecting facts is expensive. It cannot be accomplished in a short time. When Congress authorized the Interstate Commerce Commission to assemble facts, it was estimated that the desired information could be assembled for a maximum of $5,000,000, and possibly for a sum as low as $3,000,000. The work occupied engineers for eight years (1913–1921) and lawyers for ten years after that; and it finally cost $150,000,000. These are the plain facts. Approximately one-third of this amount came out of the treasury of the United States and the remaining two-thirds of it or more was furnished by the railroad companies.

This experience demonstrates the fact that it requires money to do such work, and men who are capable of administering the money in an economical manner. The facts gleaned by the Interstate Power Commission are now on record. They are organized to show the properties under the various classifications, such as: owned and used in public service; owned but not used in public service; used in public service but not owned by the corporation that is using it; and finally properties that are jointly owned and jointly used. If facts are to be made useful, they must be organized, and set forth in a

manner that will make them comprehensible not only to engineers but also to accountants, to lawyers, and to the general public.

It was the experience of the Interstate Commerce Commission that, following the actual first-hand work of collecting the facts, it was necessary to train a body of lawyers who were essentially engineers. That is what the Federal Power Commission may have to do eventually. The subject of power is so technical that it is necessary to convert engineers into lawyers and also into accountants, if they are to cope successfully with it. This is due to the fact that there are three stages to this work—the engineering, the accounting, and the legal.

It seems to me that Dr. Smith has asked the most fundamental question that can come before the Federal Power Commission at this time, "What are the facts?" In order to get them, it will be necessary first to have money, and then to have qualified or experienced men to direct the work so that it may be done in a way that will secure public confidence.

There are two ways of assembling facts by public bodies. One is to spend all the money through the public treasury. The other is to decide what is wanted and supervise the collection of the data and the actual work done by representatives of the companies. The Interstate Commerce Commission has used both methods, and good results have been obtained in either way.

In order to obtain the facts it is necessary to have the cooperation of both the public body concerned and the representatives of the companies. Information cannot be secured except by the cooperation of both parties.

EDWIN F. WENDT, M. Am. Soc. C.E.
Consulting Engineer

Washington, D.C.
April 2, 1932

Bonds for Contract Payment

DEAR SIR: The generally adopted procedure for the safeguarding of contractual relations, particularly with respect to public works contracts, has brought about a condition, the inequity of which has been greatly emphasized during the current economic demoralization. The usual contract provides that the contractor shall perform his obligations and shall safeguard the purchaser against loss and damage arising out of the contractor's failure to discharge these obligations, by furnishing a performance bond in form and amount satisfactory to the purchaser, indemnifying him against loss and damage arising out of such failure.

In return for executing the contract and furnishing the bond, the contractor receives the purchaser's unsecured promise to pay the stipulated contract price in the manner and at the times established in the contract. The purchaser, either directly or through his engineers, usually prepares the contract, which is based on the implied, fundamental conception that the purchaser's ability to discharge his obligations must not be questioned while, on the other hand, the contractor's ability to perform must be guaranteed. The unfairness of contracts executed under these conditions has become plainly evident through failures of numerous "purchasers," including some of the sovereign states of the United States, to discharge their contract obligations which consist primarily in paying the contractor his money when it becomes due.

In the event of default by the contractor, under the form of contract here discussed, the purchaser may call upon the contractor's surety and secure indemnity against loss or damage or a specific performance under the contract; but in the event of default by the purchaser, the contractor has no such recourse. Should the defaulting purchaser be a sovereign state, the problem of settlement becomes complicated by statutory provisions which prescribe the powers of officials so that a fair settlement may not be reached, and which also prevent the contractor from seeking relief through the courts. In any event, the contractor suffers loss of money and time, and embarrassment in his financial relations, which may throw him into bankruptcy before his claim for compensation can be settled.

A simple solution to the problem lies in the provision for the contractor of safeguards comparable with those provided the purchaser. A means of giving the purchaser what he wants and the contractor what he has earned, may be secured by introducing into the usual public works specifications and contract, clauses properly revised to meet the requirements of the case in hand and similar to the following:

A. Bond

Within ten days after the execution of his contract, the contractor shall furnish and keep in force throughout the life of his contract, a surety company bond in favor of the purchaser guaranteeing the faithful performance of all of his obligations under his contract. Said bond shall be in the amount of not less than one-half of the contract price. The obligation of the contractor and of his surety under this bond shall become operative upon the completion, and not before, of all of those things set forth in the contract to be done by the purchaser and the contractor with respect to the procurement, deposit, disbursement, and protection of funds out of which moneys becoming due the contractor shall be paid.

B. Contract Clause

This contract shall become binding and in full force and effect upon the instant, and not before, that the purchaser shall deliver or cause to be delivered to the Agreed National Bank of New York and, or, such other bank or depository as may be mutually agreed upon, the total amount of funds out of which all payments are to be made to said contractor by said purchaser, and these funds shall have been impressed with the trust that they shall be expended for the one purpose herein recited and for no other purpose until all sums due or becoming due said contractor from said purchaser shall have been paid.

C. Contract Clause

The purchaser shall secure from said Agreed National Bank of New York, New York, and, or, such other bank or depository as may be mutually agreed upon, a good and sufficient guarantee, satisfactory to the contractor, for the payment of funds to said contractor as payments shall become due as evidenced by estimates or certificates prepared in accordance with the provisions of the specifications and contract.

An alternate means of approach is offered through the surety companies. The purchaser might find it more advantageous to give to the contractor a bond satisfactory to the contractor, indemnifying him against losses or damages that he would sustain through default by the purchaser.

Engineers and officials of public agencies having to do with the preparation of contracts have it in their power to correct the features of these documents that have worked hardships on contractors, with whom most contracting agencies profess their desire to deal fairly. The present slackening of construction activity offers an opportunity to incorporate into standard documents such needed changes as have been here mentioned.

HARRY G. HUNTER, M. Am. Soc. C.E.
Chief Engineer, Atlantic Bridge Company

Greensboro, N.C.
April 4, 1932

Major Issues of Valuation

SIR: The paper by E. B. Black in the March issue is enlightening. The present issues of valuation deal principally with questions of theory that have not been finally disposed of by the courts. The final report of the Society's special Committee on Theory and Methods of Valuation, which was submitted in January 1917, dealt at length with questions of engineering procedure. Few such questions have developed since, and I think that it is a fair statement that, in the intervening fifteen years, the report has been generally accepted as the most authoritative discussion of valuation procedure.

At present two major issues come before commissions and courts: First, as to cost of reproduction—what is it and to what extent is it to be given weight? Second, as to depreciation—how is it to be defined in connection with valuation and what method shall be adopted in determining its amount? My remarks will be confined to these issues.

The decisions of the Supreme Court of the United States constitute a consistent and logical line of precedent dealing with cost of reproduction, commencing in the early 1890's and continuing to the present time without any change on the part of the court. The court recognized that values are not stable; that they rise and fall; and that when they fall the owner must bear the loss. When values rise the owner is entitled to the benefits. The suggestion that value can be permanently fixed by legislative decree or otherwise is not founded on any careful study of economic history.

Value in any year must be stated in terms of the money of that year. It was that money which the company received for its services and paid out for its operating expenses. Therefore, when discussing value in connection with the propriety of a schedule of rates we must discuss it in terms of money of valuation date, and not in terms of prices of some period far in the past.

Court decisions are to the effect that cost of reproduction must be given such weight as it is entitled to, and the finding of value must be reached in the light of all the facts and circumstances that have bearing on the particular case at bar.

It is of interest to note that cost of reproduction was first advanced by the public between 1895 and 1905. Then, when the war came, prices began to rise and the public shifted to prudent investment, while the utilities contended for cost of reproduction. Now the indications are that the two parties to this everlasting controversy will once more change sides.

Differing with Mr. Black, I would define depreciation, as used in valuation, as a subnormal or run-down condition below the best possible state in which the property can be perpetually maintained. From intimate contact I know that our railroads are better off now than they were 45 years or even 10 years ago. The necessity for greater operating economy has compelled heavier equipment of greater capacity. This change in equipment has necessitated the reconstruction of roadbed and bridges. The great increase in speed has necessitated improvements in safety devices and in the other facilities for operation.

Average tractive power of locomotives, average capacity and loading of cars and trains, the tons hauled one mile per ton of fuel consumed, or any other measure of efficiency that can be applied will show for any of the principal carriers steady and uniform improvement year after year over the whole thirty-year period for which we have records. In the face of these facts I cannot concede that the railroad is a depreciating utility.

I have defined depreciation as a condition that ought not to exist and I would measure the dollars of that depreciation by making an estimate of the amount of money that the company would be economically justified in spending on the property to restore it to the best possible condition in which it can be kept for its particular volume of traffic and kind of business. No correct study of depreciation can be made without giving careful consideration to operating and maintenance history over a period of at least ten or fifteen years, with the view to finding out how much the company has spent in the past to make good the depreciation, and the methods of accounting that have been used.

HENRY E. RIGGS, M. Am. Soc. C.E.

Ann Arbor, Mich.
April 8, 1932

Obstacles in Utility Location

TO THE EDITOR: The article on the "Location of Underground Utilities" in the March issue brings to the attention of engineers the fact that something must be done to correct the deplorable underground conditions being revealed by excavations for subway construction. These conditions are reproduced in the photographs on pages 178 and 179 of Mr. Consoer's article.

When New York was a small city, the utility companies placed subsurface structures which were then considered adequate to provide for many years' growth. With the advent of skyscrapers, however, both the city and the utility companies were compelled to increase the size of these underground structures and make alterations on them. In some cases they were forced to abandon obsolete structures because of development in the art of constructing them, or for economic reasons. The utility companies are now spending large sums digging test pits in congested areas to determine where, if possible, they can place new structures to meet the demands of their consumers. A central body of control would have all this information on hand.

It is regrettable to learn that the city of Chicago contemplates providing only from $3^1/_2$ to $4^1/_2$ ft. between the roof of their proposed subway and the street surface. I know that 6 ft. is little enough. Subsurface structures carry the arteries of a city, and closing the only known means of providing these necessities will hamper the growth of the city and cause the public utility companies to raise their rates, because of increased expenditures resulting from insufficient space between subway roof and street surface.

As an example of what may be expected in future growth, I shall state some of the minimum space requirements necessary in New York. A 12-in. water main should have at least 12 in. of clearance on each side, which means that a path about 3 ft. wide is required. If the main is placed so that the barrel is 6 in. above the subway roof, there will remain a 32-in. clearance from the top of the pipe to the street surface, or a clearance of about 23 in. to the base of the paving foundation. It is considered good practice to have a cover of from 3 to 4 ft. This will require an additional expenditure for the protection of the main. But a 12-in. water main will be inadequate for a skyscraper district, where mains as large as 48 in. in diameter are required. Gas mains should be given similar consideration.

Steam mains in New York are housed in multiple ducts

similar to those used for electric conduits. An 8-in. steam main housing is 3 ft. 8½ in. high and 3 ft. 6 in. wide. With a space 4½ ft. in depth, the housing of such a small main would be in the foundation of the paving. This is not a desirable condition. The housing of a 20-in. steam main is 4 ft. 10 in. high, and 4½ ft. of clearance will not be sufficient. The specifications given for water and steam mains do not take into consideration intersecting streets.

A code or guide is needed, but it can be used only in locations that are not fully developed or to be developed in the future. In some cases, however, it is possible in restoring subsurface structures during subway construction to plan for future requirements.

S. T. GOLDSMITH, Assoc. M. Am. Soc. C.E.
Flushing, N.Y.
March 9, 1932

Soil Mechanics Useful

TO THE EDITOR: The papers on building foundations by Messrs. White and Proctor, in the March issue, are unusually interesting.

The design of building foundations should be based upon an accurate prediction of the movement of the subsoil under the applied loading so that, when a subsoil that will not hold a footing exactly in place is encountered, provision may be made for future downward movement. The question of movement under a subway structure is not so serious except when the subway structure itself is a footing for future building loads.

Prediction of settlement is the vital factor in the design of the footing. Too often blind reliance is placed on a type of footing support that short-sighted experimentation seems to prove immovable, when the elementary theorems of soil mechanics demonstrate that movement is inevitable. The frequently quoted example of a structure carried on a pile footing into a bed of clay is a glaring example of failure to apply the principles of soil mechanics to the consolidation of this clay stratum. Various current periodicals carry descriptions of such footings with elaborate boring records, and although it is self-evident that consolidation will produce large settlements, the engineers designing and constructing such foundations remain blissfully ignorant of the impending catastrophe.

Although new methods of studying the subsoil, when correlated with the theorems of soil mechanics, give a fairly accurate prediction of ground movement, it is not necessary to obtain exact results. It is sufficient to find a rough range of possible settlement in order that the footing design may be so modified as to provide for future jacking of the steel columns as settlement takes place. Single load tests on the soil or on piles, where the surface is underlaid by beds of clay, are without any significance. The time effect is vital. When a clay stratum is loaded, it consolidates as the water within it is squeezed out. The rate at which this water escapes depends principally upon the structure of the clay and the load to which the individual particles are subjected.

The load distribution may be obtained by the formulas of Boussinesq. The load to which the clay particles are subjected prior to the application of the building load may be ascertained by laboratory studies on undisturbed samples. The rate at which the water may be squeezed out of the clay is likewise obtained by simple compression tests on laboratory samples. These tests have all been described in papers by Professors Terzaghi and Gilboy. It is essential to obtain undisturbed samples.

In his article Mr. White quotes from my paper on the behavior of deep layers of sand under load. Successful applications of this method were employed in the construction of the subway through Houston and Essex streets in New York City. Sand foundations differ from clay foundations in that the time effect is absent—that is, settlement of sand under load takes place within a very short time after the application of load. The distribution of load in sand may also be obtained by using the formulas of Boussinesq. The settlement may be predicted from some theorems on plastic flow coupled with intelligent soil tests, including bearing and density tests.

So far as a study of ground movement under load is concerned, the important factor in subway construction is to utilize methods of construction that minimize such movement. Ground movement disturbs neighboring structures, and Mr. Proctor has given some ingenious schemes for securing the least possible movement. Here again we may look to soil mechanics to predict such ground movement and to indicate the methods that seem most safe and yet, at the same time, economical in designing sheeting and bracing systems to sustain existing buildings and other subsurface structures. Isolated load tests are meaningless unless correlated with the geology of the ground.

It is well to recognize that ground movement is inevitable. The rôle of soil mechanics lies in the correct prediction of such movement. It is high time to drop the pleasing artifices of uniform load and "safe bearing" values obtained from single load tests, whether on the ground surface or on isolated piles.

GEORGE PAASWELL, M. Am. Soc. C.E.
Corson Construction Corporation
New York, N.Y.
April 2, 1932

Philadelphia's Subway Foundations

TO THE EDITOR: In his paper in the March issue, Mr. White has set forth two basic conditions governing the design of subway foundations—namely, groundwater and the distribution of the load of the subway structure over the soil. Both of these factors are part of our problem in Philadelphia subway construction.

We have considered the cost of waterproofing the subway floor and side walls to be prohibitive except in special conditions, and limit our waterproofing solely to the roof of the structure. Where the structure is located in wet soil, we use under-drainage which consists of 15- or 18-in. vitrified clay drains under the center of the track, with 4-in. lateral pipes extending out to the exterior of the subway wall and an intake at the approximate groundwater level. This arrangement requires the installation of automatic pumping equipment of considerable capacity, and it is our usual practice to equip each sump with two or more 750-gallon, electrically-driven, automatically-controlled centrifugal pumps which discharge directly into the city's sewerage system.

Experience has indicated that this provision is a wise one. During the summer season, we are subject to violent thunderstorms, accompanied by torrential rainfall, and on several occasions the volume of water collecting at low points in the highway system has overtopped the curb and flooded the subway through the ventilation openings as well as by running down the station stairways. In several of these instances, subway service has been

suspended for a short period, but the automatic pumps have been able, in every case, to clear the water out of the structure within a few hours.

Our first experience with treacherous soil conditions was on the four-track Broad Street Subway. When the subgrade was reached, it was found that we had stripped off an excellent bed of gravel and had reached a layer of decomposed mica rock. Within 24 hours, as the groundwater found its way up through this subgrade, the entire mass became a treacherous, sticky, muddy body. The sills and blocking that supported the street decking began to sink, and it required constant jacking-up and reblocking to keep the deck at its approximate correct level.

This material, when taken in the hand, had a greasy feeling like plumbago. Samples that were dried and examined indicated it to be a body of very fine mica sand. Inasmuch as this material appeared to be of a character that would be hard to control and would probably flow when wet under the pressure of the adjacent building foundations, it was deemed advisable to drive steel sheet piling along both sides of the subway trench and to construct a reinforced concrete slab floor for the full width of the subway along a distance of approximately 900 ft.

A rather unusual condition was encountered in the vicinity of 8th and Locust streets. At a depth of about 35 ft., a deposit of a bed of partially decayed wood was encountered about 50 ft. in width and extending approximately 500 ft. Its depth varied from about 3 to 6 ft. This deposit consisted of fairly sound knots, wood fiber, and bark that had been consolidated into a comparatively dense mass. At one point, about six large tree stumps were encountered, one of these stumps measuring approximately 5 ft. in diameter. The stumps were in a fairly good state of preservation, and one was cut up by the contractor, sawed into small blocks, and distributed as souvenirs.

Scientists who examined them differ in opinion as to the character of the wood, some claiming it to be a type of red cedar, and some cypress, as the texture is soft like that of cypress or pine. The wood fiber in the deposit appeared to have been partly carbonized, which would account for its state of preservation, although it was entirely overlaid with clay and gravel so that it was sealed from any access to oxygen. From the depth of the bed and its location under buildings dating back to Colonial days, it is evident that this deposit is of very ancient origin. I am advised by our engineers who examined the stumps that there was no clear evidence that the trees had been rooted in the position in which they were found, and it may well be that this deposit occurred at the bottom of a water-filled channel and was later silted over with clay. This material, extending principally below the subway invert, was excavated and the space filled with lean concrete.

It would appear that the essentials of subway foundation design and construction are: (1) the control of excessive groundwater flow, particularly where it carries suspended matter; (2) the removal of unsatisfactory soil encountered at subgrade and its replacement either with gravel, riprap, or lean concrete, or, where its depth is considered excessive, by the substitution of steel pipe piles filled with concrete; and (3) by the proper distribution of the subway loads on the subgrade.

CHARLES H. STEVENS, M. Am. Soc. C.E.
Chief Engineer, Department of City Transit

Philadelphia, Pa.
March 28, 1932

Prosperity for Engineers—Two Suggestions

TO THE EDITOR: There is in process at this time a change in the thought of America. People are taking a more normal view of the possibilities for progress, and it is hoped that this change will hasten the return of prosperity. Probably no other group of individuals is depending less on a miracle to end depression than are engineers. Rapidly returning prosperity is dependent upon money spent lavishly but wisely. Engineers quite generally recognize this fact.

Public funds are scarce; and for obvious reasons the return to spending large sums of public money cannot be expected in any near future. Private money, on the other hand, is available in large amounts for immediate use, when the incentive of large financial return is demonstrated. This offers special opportunity in the engineering field.

It would be well for engineers to turn their thoughts actively to new private projects which will yield attractive returns, which are economically sound, and which are logical from an engineering viewpoint. I have found it to be possible to finance such projects.

Examples of such work are the private installation of sewer and water systems and the development of ice-manufacturing plants arranged to take current at periods of off-peak load. In each community, no doubt, there are other interesting and live projects which may be developed now, at low cost, with large future return.

Suggesting that engineers take the initiative in searching out these opportunities is a new departure in engineering practice. The time has passed when the technical man may take his ease and wait for the investor to bring opportunity to his door. The procedure is now reversed. Many men are ready to invest money if the engineers of the country will present attractive suggestions. Engineers have never before had such a golden opportunity.

Of late, engineers have found themselves relegated to searching out and outlining only relatively small jobs. Why not turn engineering creative talent to the larger business of finding and planning lines of development more in keeping with the scope of engineering ability? Private capital waits on engineering perspicacity. Instead of nursing a waning hope that a miracle will be performed, why not start a movement for looking about for near-at-hand, impressive outlets for the private money which will be available in the immediate future?

In order to discover and put such projects into operation, a closer alliance between members of the profession is needed. A second suggestion thus becomes important. This is that an affiliation, temporary perhaps, between engineers of varied specialties could line up and initiate local private work in an efficient manner. If the individual engineer is now in a position to present plans to prospective investors, how much more could be accomplished by an association of several engineering specialists, for concerted action! Such a group, if organized to act, at this time has great opportunity to initiate the new prosperity.

The life of the profession and the return of engineering activity need the stimulus of united action. Larger thought and broader vision are also needed. Cooperation in planning and the selection, by engineers, of projects with large possibilities of financial returns, will do much to "start things" at this time.

E. P. GOODRICH, M. Am. Soc. C.E.
Consulting Engineer

New York
March 31, 1932

SOCIETY AFFAIRS

Official and Semi-Official

1932 Convention Meets in Yellowstone, July 6–9

Announcement that the Sixty-Second Annual Convention of the Society is scheduled to be held in the Yellowstone National Park from July 6 to 9, 1932, recalls that it is some years since a summer resort or playground district has been chosen for such a meeting. Older members will recall with pleasure former sessions at the Hotel Wentworth in Portsmouth, N.H.; others at Bretton Woods, N.H.; Thousand Islands, N.Y.; Niagara Falls; Old Point Comfort; Asheville, N.C.; and similar localities.

More recently, with the advent of the Local Section and the wonderful facilities it affords for the effective planning of such meetings, the tendency has been to favor centers of population. The reversion during the coming year to the earlier, popular practice will offer a welcome opportunity to many members. It will present the unusual privilege of participating in a Meeting program of timely interest, of renewing old and delightful acquaintances, and at the same time of visiting our most famous national park under particularly favorable and pleasant conditions.

Even before the Convention itself, an interesting program has been provided. It is planned that those traveling from the East and those from the West will meet on the morning of July 3 at Livingston, Mont., a few miles north of and outside the park proper. This point is a convenient meeting place, for it is a center for through traffic by rail from the west coast, from Chicago and the East, and from the Southeast via the Mississippi Valley. Only those coming from the Southwest will experience any inconvenience in reaching Livingston.

An additional attraction is presented in the opportunity to spend the day at the famous rodeo. The party will then leave by either train or bus for Hunter's Hot Springs about 19 miles north of Livingston. There the members and guests will have dinner and spend the night. Following breakfast on July 4 they will entrain for Mammoth Hot Springs, where they will arrive about noon.

Plenty of entertainment will be available around Mammoth Hot Springs during the succeeding 24 hours. Numerous walks, long or short, may be taken to the adjacent springs with their wonderful geological formations. If desired, longer tours and tramps may be arranged. Those interested in horseback riding or fishing will not lack the necessary facilities. In the meanwhile, the Board of Direction will be holding several sessions to complete the necessary Society business.

Rendezvous at Old Faithful

After dinner at Mammoth Hot Springs on July 5, the party will proceed by bus to the Old Faithful Inn, the scene of the Convention. This trip also takes in many of the scenic features of Yellowstone. Opportunity will be given to alight at various places to visit the springs, craters, and mud geysers, and also to stop at the famous Norris Geyser Basin.

From the Old Faithful Inn the most important geysers in the park can be conveniently reached. Each geyser has its own peculiarities, its schedules and periods. During the time of the Meeting, it is certain that visitors will be able to enjoy a variety of these spectacles. By day and by night Old Faithful keeps its almost hourly schedule with the utmost regularity. The inn is one of the large ones in the park and is especially well fitted to be the Convention Headquarters and to handle the necessary sessions. Here also, museums, hikes, and side tours are available to take up whatever time remains. The nightly practice of feeding the bears is a prominent feature.

As to the Convention itself, it will open on Wednesday morning, July 6, with the annual address of the President of the Society. Succeeding him, Horace M. Albright, Director of the National Park Service, will describe "The National Parks and Their Improvement." That afternoon the sessions will be continued with a paper by Herman Stabler, M. Am. Soc. C.E., Chief of the Conservation Branch, U.S. Geological Survey, in which he will deal with "The Rise and Fall of the Public Domain." Still another paper of particular interest is that by W. G. Hoyt, M. Am. Soc. C.E., and H. C. Troxell, Assoc. M. Am. Soc. C.E., both of the U.S. Geological Survey. Their studies cover the much discussed subject of "Forests and Stream Flow," including some very interesting new developments.

An entertainment is being provided for Wednesday evening. Following dinner at the inn, Dr. Richard M. Field, Professor of Geology at Princeton University, will deliver his interesting address on the geology of Yellowstone Park. He is an authority on this subject and a lecturer of repute. Every visitor will leave this session with a far clearer idea than he had before of the basic geological principles underlying the formation of this curious and marvelous region.

Thursday, as usual, will be given over to sessions of the Technical Divisions. The Irrigation, Power, Structural, Highway, and Construction Divisions have each arranged interesting programs. An attempt is being made to avoid too much overlapping of these sessions so that as many members as possible can enjoy the interesting topics presented at each.

At the opening session on Wednesday, Vice-President D. C. Henny, representing Zone IV, will preside. Other members of the Committee on Arrangements include Directors Frederick C. Herrmann, Franklin Thomas, J. C. Stevens, and E. B. Black. Following the technical program, the committee has arranged for a

geological tour of the park, to start on Friday. Friday afternoon and evening will be spent at the Canyon Hotel on the brink of the Grand Canyon of the Yellowstone. On Saturday, trips will be made to Roosevelt Lodge, one of the most scenic parts of the park, and to other points of interest.

Departure from Yellowstone toward the East is scheduled for Sunday, or possibly Saturday afternoon, by way of the famous Cody entrance. This trip as far as Cody, Wyo., by bus, is properly considered one of the most remarkable and scenic in the country. The route traverses a beautiful mountain highway, leading almost from the continental divide, past Lake Yellowstone, down through

OLD FAITHFUL GEYSER FROM OLD FAITHFUL HOTEL

the Rockies to the head of rail transportation at Cody, passing on the way the famous Shoshone Dam and the picturesque canyon just below it. By all authorities this trip is considered a most fitting finale for any visit to Yellowstone.

Throughout the entire trip it is hoped to have the unusual opportunity of an escort of geologists, headed by Professor Field, who will give a comprehensive view of the geology of North America. Full details of the Convention, including the official program, will appear in the June number of CIVIL ENGINEERING.

Scholarships Available

Two admirable opportunities for study are presented to young American engineers under the Freeman Traveling Scholarship, and the Horatio Allen Scholarship at Columbia University. Both these offers should be of much interest to engineers who wish to study under favorable conditions.

The Freeman Traveling Scholarship is available for one year beginning July 1, 1932. It yields $1,600 during the year and gives the student the advantage of studying European practice in hydraulics. The requirements for this scholarship are high, but its value is correspondingly great.

The Horatio Allen Scholarship at Columbia University is for the academic year 1932–1933. It has a monetary value of about $700. Applications should be in the hands of the Secretary of the Society before June 1.

Both these scholarships were announced as available in the April issue of CIVIL ENGINEERING. Full information can be secured from the office of the Secretary of the Society.

Women Aid in Relief Work of Metropolitan Section

The funds collected for relief work among unemployed engineers in New York City have been augmented by the proceeds of a contract bridge party, given under the direction of the Engineering Woman's Club. The net proceeds, amounting to $1,163.16, were turned over to the fund by the committee in charge, of which Mrs. Frederick C. Noble acted as chairman, and Mrs. W. W. Brush as vice-chairman. The party, which was held in the Engineering Societies Building, had also the sponsorship of a large number of prominent engineers.

On the evening of the entertainment, March 17, Mrs. George D. Barron, president of the Engineering Woman's Club, told those present of the help received from many interested individuals and organizations, who contributed generously both of supplies and of personal services, so that the expenses were reduced to a minimum. Charles M. Schwab then introduced the well known bridge expert, Ely Culbertson, who gave a brief and witty address, reciting some of his own experiences.

The Engineering Woman's Club for some time has been interested in the welfare work of the Professional Engineers Committee on Unemployment functioning under the Metropolitan Section of the Society, and has assisted particularly in the matter of clothing for those in need. The substantial contribution now made to the committee's funds gives the club a leading place in the relief activities of the Section.

Emergency Planning and Research Bureau, Inc., of Boston

Sponsored by all the engineering and architects' societies of Boston, the Emergency Planning and Research Bureau, Inc., has been organized and is carrying forward the work of relief for the unemployed of these professions. The unique part of the Boston effort is that the employees of the bureau are engaged in carefully selected projects of research and planning which will be of public benefit, thus giving the public the benefit of technical ability and foresight at the same time that technical men are being helped over the period of depression.

The following are typical projects on which the bureau is working:

- Maps showing public and semi-public buildings
- Valuation map of the city proper
- Special maps and studies desired by the City Planning Board
- Studies of the North End, South End, South Boston, and East Boston, charting uses of all properties, including obsolete properties
- Statistical studies with state departments
- Reservation mapping with the Metropolitan District Commission
- Run-off studies
- Smoke-nuisance studies
- Work for the New England Building Officials Conference

It was agreed when the organization was set up that the bureau's activities must not compete with the work of architects or engineers regularly employed; and also that the work done by the bureau must be of a useful, productive sort.

So far, the work of the bureau has been financed by architects and engineers, each profession taking care of its own men. The architects of Boston have contributed $20,000 and the engineers have contributed $73,000. It is hoped that the work of the bureau will prove of enough interest to public spirited citizens outside the two professions so that further support for the continuance of the projects will come from outside sources. The faculty of the Massachusetts Institute of Technology, with which the bureau has a liaison, has raised $6,000 for similar work.

During the time the bureau has been active, 669 men of the two professions have registered for work. Of these, the bureau has employed 149, and 68 have been placed outside the bureau. These data are taken from the report of April 7. Although placements of the needy men have not exceeded a third of those registered, the fact that during the last week only 11 new applications were received is an encouraging feature. The men are given employment as rapidly as possible, in the order of their needs. The standard

wage is $15 a week for five days of work. The payrolls of the bureau are running over $3,000 a week.

Steady effort has been directed to securing regular employment. The men have been urged to look for permanent jobs and assisted in their efforts. Careful consideration is being given to the problem of employing either a greater number of men for a shorter time or a lesser number of men for a longer time. Thought has also been given to the overcrowding of the two professions, and some young men have been advised to seek employment in other lines of work.

The activity of the bureau is threefold: it functions as a relief agency, an employment exchange, and a planning and research organization for public benefit. Its work is based on the idea that engineering ability may be used now for public welfare at the same time that the men of the technical professions are being helped. The Northeastern Section of the American Society of Civil Engineers is one of the 13 units sponsoring the activity of the bureau.

Council of Los Angeles Engineers Formed

A new grouping of members of the Founder Societies, known as the Los Angeles Engineering Council of Founder Societies, has completed its organization and is functioning on a plan which was recommended by the Public Relations Committee of the Los Angeles Section of the Society. The efforts of the committee had expanded to a point where it was felt that civic interest in public welfare by all engineers required the combined support and guidance of the engineering fraternity as represented by the Founder Societies.

On August 8, 1931, representatives of the four societies, together with other engineers interested in the movement, met and decided to form such an association, the organization meeting to be called by the Los Angeles Section of the Society. Since that time the organization has been completed and plans outlined for proceeding with certain lines of endeavor. The constitution of the council states as its purpose: "The object of the council shall be to further the public welfare wherever technical and engineering knowledge and experience are involved, and to consider and act upon matters of common concern to the engineering profession." For the present, the membership is limited to members of the four Founder Societies. It is expected that as the activities expand, members of other local or regional engineering societies may be included.

The Executive Committee of the recently formed Los Angeles Engineering Council is as follows: president, Robert Linton, representing the American Institute of Mining and Metallurgical Engineers; vice-president, Carl Johnson, representing the American Institute of Electrical Engineers; secretary-treasurer, L. W. Voorhees, representing the American Society of Mechanical Engineers; and A. F. Barnard, Assoc. M. Am. Soc. C.E., representing the American Society of Civil Engineers. Of the other eight members of the council, those representing the society are: Frank Gillelen, Assoc. M. Am. Soc. C.E., and Ralph J. Reed, M. Am. Soc. C.E.

The agenda of proposed activities are prepared by the council and referred to the member societies for approval. The member societies may suggest special projects. The by-laws of the council provide for three standing committees: on Engineering Education, Civic and Government Affairs, and Registration. This gives an idea of the trend of the activities that will come under the council routine. The council also plans to sponsor joint meetings.

In commenting on the council, A. F. Barnard, Assoc. M. Am. Soc. C.E., a former president of the Los Angeles Section, says in the March 1932 issue of "ASCE," the official publication of the Los Angeles Section:

"During the formative stage and since the organization of the council, the representatives of the Civil Engineers have been looked to for guidance and suggestions, since our members are probably more interested and more widely employed in public engineering projects. It is too early to know what results may be accomplished by the council, but it is believed that the organized efforts of such a body of professional men should be of value in connection with public interest in the large public works which are being constructed every year in this vicinity. The council is proceeding with caution in all matters having a political aspect, but it proposes to make proper inquiry into legislation of engineering interest: Federal projects, local public works, engineering investigations of broad scope, registration of engineers, and employment of engineers."

As one of its first activities, the council has set up a special committee of employment, which is cooperating with the local committees of the American Engineering Council and the American Association of Engineers. The long-established employment service of the latter has been extended and additionally financed by the local sections' members through the council.

New York License Bill Amendments Become Law

As stated in the April CIVIL ENGINEERING, the long-standing difficulties between architects and engineers in New York State, covering mutual interests in the building field, have been resolved. Amendments to the license laws for both professions, prepared with the help of committees of architects and engineers working with the State Department, clearly define the prerogatives of each profession, give the differences and likenesses of the practices, and settle certain critical points of controversy.

The bills embodying these amendments were passed by the legislature at its recent session and signed by Governor Roosevelt on March 29.

Year Book for 1932 Mailed

During the early part of the month of April, there went out in the mails from Baltimore, where the volume had been printed and bound, about 15,000 copies of the 1932 *Year Book* of the Society. By the time this issue of CIVIL ENGINEERING comes to hand, all those of its readers who are also members of the American Society of Civil Engineers, scattered over the surface of the earth, from Alaska to Johannesburg, will have received also their copies of the *Year Book*.

Probably the part of this annual publication that is most often referred to is the list of members, complete up to March 1, and arranged both alphabetically and according to geographical distribution. The double column arrangement of this list, which was adopted last year, has proved a practical one, and saves several pages in the printed book.

Probably the next most frequent use of the volume is due to the fact that it is the authority on the Constitution and By-Laws of the Society, with the latest amendments incorporated. Much other information is included, of value both to the member and to the inquiring non-member. Then, too, the *Year Book* serves as a roster of the hundreds of members who are actively engaged in Society activities. Copies may be obtained by non-members at the price of $2.

American Engineers Mourn Suyehiro

News that the eminent Japanese engineer, Kyoji Suyehiro, died in Tokyo on April 9, 1932, came as a great shock to many American engineers. His lecture tour through this country was of such recent date and he had been so warmly received that his death soon after reaching home was almost unbelievable.

When Professor Suyehiro came to this country last fall, his name meant little to Americans except that he was an engineer and scientist who had had marked success in translating research in seismology into practical engineering results. Through the medium of his lectures, his reputation was confirmed and enhanced. Furthermore, engineers came to know and admire him for himself as well as for his attainments.

Seldom does an eminent foreign visitor leave such a marked impression as did Professor Suyehiro. To most of those who had an opportunity to listen to his lectures, he appeared as an earnest investigator, with an uncanny knack of getting results in a rather difficult field. But to those who were privileged to meet him in a social way, if only for a few minutes, the real man was revealed—a quiet, intensely modest person, with a boundless fund of humor, a wide sympathy, and a great ambition for service.

He left the world his debtor. To the Society he made a definite contribution, not only in a series of fascinating lectures, of which the notes are shortly to be printed in PROCEEDINGS, but in strengthening international good will. Many members of the Society will unite in mourning the death of this accomplished yet unassuming Japanese gentleman

Society to Support Public Works Programs

At a meeting of the Society held in New York on March 24, 1932, the following resolution was adopted:

> WHEREAS, The Professional Engineers Committee on Unemployment, representing the Metropolitan Sections of the four Founder Societies in the New York metropolitan district, has appointed a subcommittee charged with the responsibility of urging upon the Congress of the United States the need for a sustained program of public works; and
>
> WHEREAS, It is the sense of this meeting that a sustained program of public works is essential in preventing a further spread of unemployment, especially among engineers; and
>
> WHEREAS, Such a sustained program would be of inestimable value to the industries, to the transportation agencies, and other business;
>
> *Be it resolved*, That the American Society of Civil Engineers does hereby endorse the action of the Professional Engineers Committee on Unemployment in urging upon Congress the need for support for a sustained program of public works by the Federal Government, the states and municipalities; and further
>
> *Be it resolved*, That all the local sections of these societies be urged to lend their support to the movement thus initiated.

The Subcommittee of the Professional Engineers Committee on Unemployment appeared at a hearing on the La Follette Public Works Relief Bill (Senate Bill 2419) where they strongly favored the proposal to maintain and increase public works by direct Federal appropriations, or by Federal loans, to cities or other local governments. At the same time there was definite expression of the fact that the La Follette Bill as drafted provides for a method of financing, and a method of administration, which was not considered satisfactory. More than one member of the subcommittee recommended a public corporation similar to the Reconstruction Finance Corporation to buy the securities of cities and hold them until they could be resold.

Copies of the resolution have been forwarded to the presidents and secretaries of the Local Sections with the reminder that they are "urged to lend their support to the movement thus initiated." This can be done no better than by concentrated and individual action in bringing the matter promptly to the attention of United States Senators and Representatives.

Appointments of Society Representatives

PHILIP A. BEATTY, DAVID C. COYLE, and WILLIAM EASBY, JR., Members Am. Soc. C.E., were appointed to represent the Society at the 36th Annual Meeting of the American Academy of Political and Social Science in Philadelphia, on April 15 and 16. Previous appointments were R. C. Marshall, Jr., D. H. Sawyer, and Ezra B. Whitman, Members Am. Soc. C.E.

F. L. THOMPSON, M. Am. Soc. C.E., has accepted an appointment as one of the Society's representatives on the Washington Award Commission.

American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

SPRING MEETING OF THE ADMINISTRATIVE BOARD

The spring meeting of the Administrative Board of the American Engineering Council will be held May 13 and 14, 1932.

TOPOGRAPHIC MAPPING APPROPRIATIONS STILL THREATENED

The Interior Department Appropriation Bill, which carries the items for topographic mapping and stream gaging, has been referred back by the Senate to the Committee on Appropriations with instructions to return the bill with a total amount appropriated of 10 per cent less than the amount carried in the bill when it passed the House of Representatives. The bill, as it passed the House, provided for an appropriation of approximately $50,000,000. The Senate committee had reported the bill back to the Senate with increases of approximately $5,000,000, making the total approximately $55,000,000.

Under the recent instructions, the committee must bring in a bill totaling approximately $45,000,000. This will undoubtedly mean a very serious reduction in many of the public works activities of this department. Thus far the Appropriations Committee has taken no further action relative to the bill. It is believed the committee has been holding the matter in abeyance until action is taken on the 1932 Revenue Bill, which has now passed the House. The amount of money which this bill would secure through taxes will give a definite indication of how much departmental expenditures must be reduced in order to carry a balanced budget for the next fiscal year.

PUBLIC WORKS PROJECTS SURVEY FOR 1932

In conjunction with the American Institute of Architects and Associated General Contractors, the American Engineering Council is cooperating with the Public Works Section of the President's Organization on Unemployment Relief, in a survey of 1932 public works projects. The Council's state committees on engineers and employment are cooperating in this undertaking.

This work has three important phases, the first of which is the collection and dissemination of information relative to all planned public and semi-public works projects for 1932. It is hoped that this part of the work can be consummated by May 15. The second phase involves checking up on the progress being made. The third, and most important phase, is the stimulation and promotion of such of these planned projects as are delayed or postponed for any reason.

HEARINGS ON BRIDGE CLEARANCES CONTINUED

During 1932 the Corps of Engineers has continued its program of hearings on horizontal and vertical bridge clearances. Thus far in 1932 hearings have been held on clearances over certain rivers in Connecticut, Illinois, North Dakota, and Rhode Island. The purpose of these hearings is to develop information which may lead to the adoption of minimum bridge clearances for the principal rivers and waterways of the United States. As rapidly as these hearings are announced by the Corps of Engineers, the Council notifies all local and state engineering societies in the vicinity so that such of their membership as are interested may attend and make appropriate presentations.

BILL FOR REORGANIZATION OF PUBLIC WORKS FUNCTIONS OF FEDERAL GOVERNMENT

The Committee on Expenditures in the Executive Departments of the Federal Government has reported out a bill (H.R. 11,011) introduced by J. J. Cochran of Missouri, authorizing the President to reorganize the public works functions of the Federal Government. The bill excepts the construction activities of the Army and Navy, which exempts from inclusion in the Public Works Administration the River and Harbor activities of the Corps of Engineers of the Army, one of the major public works activities of the Federal Government. This would reduce the amount to be saved through consolidation.

The new bill is similar to the Williamson bill (H.R. 6,665). It would give the President authority by executive order, to transfer to the Public Works Administration, and to consolidate and coordinate therein, the whole or any part of all bureaus, agencies, offices, activities, and services, whether now existing in any executive department, independent establishment, or as an independent activity, having to do or that are concerned with the architectural, engineering, surveying, designing, drafting, construction, and/or purchasing activities of the Government relating to public works administration, and/or that are engaged in the making of plans, specifications, contracts, and/or the supervision of public construction, and the transfer of any activity to the Public Works Administration.

A Preview of Proceedings

The May 1932 issue of PROCEEDINGS *will appear in two parts, Part 1 to contain two main papers and a committee report, as well as discussions, and Part 2 to be made up of lecture notes on engineering seismology by Dr. Ing. Kyoji Suyehiro. The following brief outline and comments may prove helpful as forecasts of this interesting number.*

IMPROVEMENT OF HUDSON RIVER BY NARROWING THE NAVIGABLE FAIRWAYS

When the navigable fairway of an important river is narrowed by successive alterations of the established pierhead line, what effect may be expected in the hydraulic regimen of such a waterway? This question, applied specifically to pierhead extensions in the Hudson River west of Manhattan Island, has been treated by Lynne J. Bevan, M. Am. Soc. C.E., in a terse and decisive paper of less than a dozen pages. Data and profiles are presented to show that successive encroachment by the piers has set in action natural forces which have scoured the river bottom, so that the cross-sectional areas have actually been increased, with a substantial saving in the cost of dredging. Contrary to generally accepted statements, according to Mr. Bevan, these encroachments have actually decreased tidal-current velocities. Narrowing a broad natural waterway and simultaneously increasing its depth decreases the tendency to create cross currents, increases the hydraulic radius, decreases the mean velocity necessary for a definite quantity of water, and tends to make velocity more uniform throughout the cross section.

APPLICATION OF DURATION CURVES TO HYDRO-ELECTRIC STUDIES

In their paper on the application of duration curves to hydro-electric studies, G. H. Hickox and G. O. Wessenauer, Juniors Am. Soc. C.E., define an arrangement of daily stream-power capacities in the order of their magnitude as an output duration curve. The ordinates represent kilowatts, and the abscissa for any ordinate represents the percentage of time during which stream-power capacities greater than that ordinate occur. This

LAKE LYNN DAM AND POWER HOUSE
The First Hydro-Electric Development Constructed in the Cheat River Basin, West Virginia

paper outlines an accurate method of determining the reliable power-rate, plant, and reservoir capacities for a combination of hydro-electric plants and reservoirs on streams with similar flow distribution.

This study is the result of an investigation of the power possibilities of the Cheat River by the West Virginia Power and Transmission Company. Beginning with three basic assumptions, the authors describe in detail four hypothetical cases. The assumptions are: (1) that the streams under consideration have the same distribution of flow; (2) that the water discharged from an upper plant is immediately available for use at the next plant downstream; and (3) that the storage available at each reservoir is unlimited.

In the order of presentation, the cases are combinations of a run-of-river plant with: (1) a storage plant on adjacent streams; (2) a storage plant on the same streams; (3) a partial storage plant on the same streams; and (4) two storage plants.

Data are presented showing the comparative accuracy of the methods using hydrographs and duration curves. The authors conclude that the latter method is rapid and accurate; that it requires little work for preparation except the construction of the necessary curves, and that it eliminates the "cut-and-try" process of the hydrograph method, in which a rate of use must be assumed and a study completed with such rate before it is known whether the reservoir will fill. The duration-curve method insures a full reservoir at the end of a period, and the authors point out that the graphical results show the distribution of load—and the effects of changes in that distribution—more effectively than any tabulation.

STANDARD SYMBOLS AND GLOSSARY FOR HYDRAULICS AND IRRIGATION

In its extensive work covering the past ten years, the Society's Special Committee on Irrigation Hydraulics has found marked differences in the interpretation of symbols and terms used in its field. It therefore conceived the idea of having some authority, such as itself, set up a basis for uniform treatment. In the course of formulating these standards, the committee was further impressed with the difficulty of obtaining uniformity, and hence came to the conclusion that a thorough dissemination of its recommendations and their discussion were necessary for the development of what could in fairness be considered a standard compilation of terms.

In presenting this series of symbols and definitions in the May PROCEEDINGS, the committee anticipates that possibly members will differ as to proper interpretations and exact wording. In other words, the present forms are not submitted as authoritative or final, but merely as the committee's best judgment at the present moment, subject to whatever changes or improvements are shown to be necessary by the comments. Although the present compilation is not open to written discussion in PROCEEDINGS, any comments are welcome and will be transmitted to the committee for its information. Eventually it is expected that the entire list may be thus corrected and given a form of authority that will warrant its widespread use as the authentic choice of engineers qualified to judge.

Proceedings, Part 2

ENGINEERING SEISMOLOGY; NOTES ON AMERICAN LECTURES

At the instigation, and through the generosity, of John R. Freeman, Hon. M. and Past-President Am. Soc. C.E., the Society was enabled in November and December 1931, to persuade an eminent engineer seismologist from Japan to lecture before engineering bodies in the United States on the subject of engineering seismology. Dr. Ing. Kyoji Suyehiro delivered addresses at the University of California, Stanford University, the California Institute of Technology, and the Massachusetts Institute of Technology, in addition to several before independent groups.

Ever since the California earthquake of 1906, which led to the destruction of a large part of the city of San Francisco by fire and caused serious losses at Berkeley, Santa Rosa, Petaluma, San José, and many smaller communities within a distance of nearly 200 miles along the great San Andreas Fault, the Society has been actively interested in earthquake dangers. From time to time it has appointed committees composed of eminent engineers familiar with conditions, to study the various features of earthquake damage to engineering structures and to formulate rules for obtaining greater safety. In this committee work the cooperation of Japanese engineers has been extremely helpful.

The first work of importance was inaugurated by the San Francisco Association of Members of the American Society of Civil Engineers on April 28, 1906, ten days after the earthquake.

The report of the general committee and subcommittees on this work appears in TRANSACTIONS for December 1907.

On October 16, 1923, after the great Japanese earthquake, the Society authorized the organization of a Special Committee on Effects of Earthquakes on Engineering Structures with Special Reference to the Japanese Earthquake of September 1, 1923. The first report of the committee appeared in PROCEEDINGS for February 1924, followed by another in March 1926.

ERUPTION OF ASAMA-YAMA, JAPAN, 1912
From the Bulletin of the Imperial Earthquake Investigation Committee, Vol. 7, No. 1

In January 1929 the committee submitted a monumental report bearing witness to a tremendous amount of valuable work in this field. Because it was estimated that the publication of this report would entail the production of a book more than 800 pages in size, the Society found it financially impossible during the intervening years to make this vast wealth of information generally available to its members. However, it is hoped that one complete copy will be placed on file for reference in the Engineering Societies Library in New York, and another at an accessible point on the Pacific coast.

In addition to sponsoring the visit of Dr. Suyehiro to this country, Mr. Freeman has himself advanced the cause of greater knowledge of earthquakes by his recent publication of the book entitled *Earthquake Damage and Earthquake Insurance* (1932).

At the International Engineering Congress held in Japan in October and November 1929, numerous papers were presented dealing with the results of Japanese researches, looking toward greater safety to life and property. Several members of the Society became especially interested in the history of the studies by members of the Japanese Earthquake Research Institute.

About twenty-five years ago modern practical seismology as related to earthquake-resistant structures became highly developed in Japan. Such progress had been made that when the great earthquake of September 1, 1923, and the fires that followed, laid waste the greater part of Tokyo and Yokohama with a loss of approximately 200,000 human lives, structural plans for safer buildings had been worked out. A considerable number of large buildings, many of them eight stories in height, had been conconstructed according to these plans and resisted this extremely violent earthquake wonderfully well. It was apparent to some of those attending the International Engineering Congress that no one person could bring to the United States the story of this research and what it had accomplished more effectively than Professor Suyehiro, the Director of the Earthquake Research Institute of Tokyo Imperial University, particularly as it was proved that researches under his direction were mainly of an engineering nature and pertained more directly to structural engineering than to geophysical research.

The institute regularly publishes a journal in which the results of these researches are set forth, primarily in the Japanese language but also in many cases with great fullness in English, and occasionally in French. This publication, which was begun soon after the great earthquake of September 1, 1923, appears under the English title of *Bulletins of the Earthquake Research Institute of Tokyo Imperial University* and up to the present time comprises eight annual volumes. These bulletins and the three-volume report of the Civil Engineering Society of Tokyo upon the great earthquake of 1923, are on file in the Engineering Societies Library.

The notes of the American lectures by Dr. Suyehiro are to be published as Part 2 of the May PROCEEDINGS. They are in an informal style and are presented for record and for general interest. To the many members who could not hear Dr. Suyehiro in person, these notes will bring the essence of his addresses, constituting one of the last contributions of his great career. These notes will not be open for discussion.

DISPLACEMENT ALONG IDU PENINSULA FAULT IN TANNA BASIN
Road Moved 3 Ft. in Earthquake of 1930

IN THE WAKE OF THE IDU EARTHQUAKE, 1930
Wooden Structures, Properly Braced, Were Undamaged

News of Local Sections

CENTRAL OHIO SECTION

A talk by E. G. Bradbury on "Jacking a Forty-Eight Inch Pipe Under a Main Line Railroad," was thoroughly enjoyed by all who attended the March 17 meeting of the Central Ohio Section. The talk was illustrated by a motion picture taken and shown with the Section's equipment.

CLEVELAND SECTION

Business routine occupied the greater part of the session of the luncheon meeting of the Cleveland Section held on April 5. "Unethical Practices and Unemployment of Engineers" was the title of a paper read by Wendell P. Brown. Among those contributing to discussion of the paper were Messrs. Brown, Duff, Sabin, Gascoigne, and LeFeber. There were 40 members and guests in attendance.

COLORADO SECTION

The 209th regular meeting of the Colorado Section was held on February 8, with 49 members and guests present. The program for this meeting was arranged by the junior members, and the subject for discussion was "Engineering Education." The program proved to be very well balanced and most interesting to all present. The first speaker, D. E. Carberry from the California Institute of Technology, discussed briefly California's engineering schools. Following this, E. D. Smith from Drexel Institute gave an interesting talk on cooperative technical schools. The advantages and disadvantages of a liberal arts course as a prerequisite to an engineering course, were then discussed by A. W. Adkins, of the University of Pennsylvania; and F. C. Hart, of the University of Colorado, discussed engineering schools of this state.

At the next meeting of the Society, held on Monday evening, March 14, Herbert S. Crocker, President of the Society, and Roy C. Gowdy, Former Director of District No. 16, were the guests of honor. An interesting talk on the activities of the Society, with special reference to the last meeting of the outgoing Board of Direction in New York, was given by Mr. Gowdy, after which President Crocker spoke briefly concerning the activities of the Society and its plans for the coming year. A "talkie" on the manufacture of Mazda lamps, shown by the General Electric Company, was thoroughly enjoyed by all.

DAYTON SECTION

At the regular monthly meeting of the Dayton Section, held on March 14, Prof. Bernard T. Schad, Dean of Civil Engineering, University of Dayton, and Chairman of the Public Safety Committee of the Chamber of Commerce, spoke on "The Progress of Public Safety Work in Dayton." Professor Schad discussed the construction of safety zones in Dayton and various other subjects which have come up in connection with his work as chairman of the Public Safety Commission.

FLORIDA SECTION

A dinner meeting and social evening, honoring Herbert S. Crocker, President of the Society, and George T. Seabury, Secretary, were enjoyed by the Florida Section in Jacksonville on February 18.

GEORGIA SECTION

A well attended meeting of the Georgia Section was held on March 7. A very interesting talk on hydro-electric developments in Brazil was given by W. E. Mitchell, Vice-President of the Georgia Power Company. Mr. Mitchell illustrated his talk with maps and charts.

ITHACA SECTION

The Ithaca Section held its second meeting on Monday evening, March 28. The meeting was preceded by a dinner at Willard Straight Hall on the Cornell campus, at which Harold M. Lewis, and Dean Kimball of the Engineering College were present as guests. After a short business session an interesting lecture on "The Highways of New York" was given by Mr. Lewis.

KANSAS STATE SECTION

At the Annual Meeting of the Kansas State Section, held at Topeka on January 23, there were 38 members and guests in attendance. The speaker for the occasion was S. S. Larned of Bartlesville, Okla.

LOS ANGELES SECTION

The April meeting of the Los Angeles Section was held on Wednesday, April 13, at the Student Union Building, University of Southern California, with the Student Chapter acting as hosts. A short "Current News Reel" feature describing the recent and proposed improvements at Fish Harbor in Los Angeles Harbor, was given by E. C. Earle, Assistant Harbor Engineer. Following this, a brief talk on football was given by Tom Mallory. The main progam consisted of a symposium on "Petroleum Engineering." A. J. Tieje, Professor of Geology at the University of Southern California, gave a talk on oil geology and also described the recent attempts in Texas, Oklahoma, and Louisiana to control oil production by military and other methods. Some interesting facts concerning the causes of the present over-production in oil, were given by J. E. Dodge, Professor of Petroleum Engineering, University of Southern California; and L. B. Metcalfe, Manager of Refineries, Union Oil Company, described the various types of crude oil found in the Pennsylvania, Mid-Continent, and California fields. A trio from the university furnished the musical entertainment.

A diversified and interesting program was presented before the Sanitary Group of the Los Angeles Section on March 23. A talk on "Methods of Controlling Surge and Water Hammer Caused by Sudden Closing of Check Valves in Pumping Lines," was given by E. A. Rutledge of the Rensselaer Valve Company. Upon the conclusion of this address, Chester A. Smith, of Burns-McDonnell-Smith Engineering Company, presented a paper entitled "Why Shouldn't Southern California Soften Water?" After this the subject of "Sewer Disintegration in Southern California" was discussed by E. H. Clarkson, of the Los Angeles Sewer Department, and A. M. Rawn, Assistant Chief Engineer of the Los Angeles Sanitation District. An open-forum discussion of the subject of disintegration followed the talks by Messrs. Clarkson and Rawn. The attendance was 43.

MARYLAND SECTION

On Friday evening, February 19, the Section held a joint meeting with the American Society of Mechanical Engineers, the American Society of Electrical Engineers, and the Engineers' Club of Baltimore. The meeting was addressed by Leon Small, Water Engineer of the Bureau of Water Supply, on the subject of the Vernon and Guilford pumping stations, which are electrically operated and have a number of interesting features. After the lecture, an inspection of both of these stations was made.

MILWAUKEE SECTION

The speaker of the evening at the March 2 meeting of the Section was Dr. C. M. Purin, Director of the Extension Division of the University of Wisconsin, who gave an interesting address on "Russia." He pictured the life of the Russian people during the Czarist rule and showed their economic situation today by comparison.

NORTHEASTERN SECTION

A special meeting of the Northeastern Section was held on Friday, March 11. After a luncheon served to 28 members and guests, Harvey A. Wooster, Director of the Massachusetts Special Commission on Stabilization of Employment, spoke on "Public Construction as a Means of Dealing with Unemployment." A brief talk by Harrison P. Eddy on the water works betterment plan of the American Water Works Association was followed by a discussion by Frank M. Gunby of the work of the American Engineering Council and of the Emergency Planning and Research Bureau, Inc. Officers for 1932 are: H. K. Barrows, President; A. D. Weston, Vice-President; and H. P. Burden, Secretary-Treasurer.

PHILADELPHIA SECTION

The subject of the March meeting of the Philadelphia Section was "The George Westinghouse Highway Bridge," which carries

the Lincoln Highway over the Turtle Creek Valley in East Pittsburgh. There were 62 members and guests assembled for dinner and 94 in attendance at the meeting. A discussion of future traffic economies amounting to over $400,000 annually, which are anticipated by the use of the new bridge and highway relocation, was given by Paul M. Tebbs, Assistant Chief Engineer, Pennsylvania State Highway Department. Following this discussion, George S. Richardson, Assistant Engineer, Bridge Design, Bureau of Bridges, Allegheny County, spoke on the design of the bridge. A paper on the construction of the bridge, prepared by George Hockensmith, Vice-President of Booth and Flinn, the firm which erected it, was read by T. E. Harbaugh, also of Booth and Flinn. Mr. Harbaugh then described the organization and methods used to complete the job within 20 months, which represents unusually fast working time. The importance of tests on materials was discussed by P. J. Freeman, Chief Engineer, Bureau of Tests and Specifications, Allegheny County, after which interesting moving pictures showing the progress of construction were presented.

SACRAMENTO SECTION

"Frost Prevention," was the subject of an address presented at the February 2 meeting of the Section, by W. R. Shoonover, Extension Specialist in Citriculture, University of California.

At the February 9 meeting, T. H. Dennis, Maintenance Engineer of the State Division of Highways, presented a paper on "Fighting Snow on California Highways." This was illustrated by motion pictures. On February 16, Hugh R. Pomeroy, City Planning Engineer, gave an address on "Regional Planning." The next three meetings of the Section were devoted to a discussion of the relief of unemployment among engineers.

A meeting held on March 8 was addressed by George E. Goodall, a navigator in the U.S. Navy during the World War, who spoke on "Navigation."

SEATTLE SECTION

A joint meeting of the Four Founder Societies was held on Monday, March 21. Following dinner, Lloyd Spencer, former president of the Seattle Ad Club and the Pacific Coast Advertising Club, entertained with several anecdotes. An interesting description of new uses for timber was then given by Chester J. Hogue, of the West Coast Lumbermen's Association; and following this, Dean Hugo Winkenwerded, speaking on "Forestation," stressed the importance of conservation and reforestation for the State of Washington.

SPOKANE SECTION

At the last regular meeting of the Section held on March 11, an interesting talk regarding the history and present status of the Society was given by J. C. Stevens, Consulting Engineer of Portland, Ore. Also A. D. Butler, City Engineer of Spokane, gave a very interesting and instructive description of his problems in caring for approximately 4,000 unemployed men.

ST. LOUIS SECTION

A joint meeting of the St. Louis Section and the Student Chapter of Washington University was held at the Engineers' Club on March 8. The principal talk was given by Col. F. G. Jonah, who discussed the development of transportation, beginning with the earliest primitive methods and tracing them down through history to the present time. A moving picture showing views of the construction of a New York subway was presented by the students.

There were 60 members and guests in attendance at the regular monthly luncheon held on Tuesday, March 22. The Section had as its guests President Crocker, Past-President Stuart, and Dean Milo S. Ketchum. President Crocker spoke on Society affairs, finances, and new activities; Past-President Stuart told of the aims of the Construction League; and Dean Ketchum spoke of the engineer as a human being, and stressed the value of association and experience in forming judgments and reaching conclusions about people as well as projects.

TACOMA SECTION

A regular meeting of the Tacoma Section was held on the evening of March 14. Several interesting addresses were given. Among those who spoke were: Samuel Humes, Director of Highways; Bailey Tremper, Engineer of Tests; O. R. Dinsmore, District Engineer; and H. G. Porak, Construction Engineer—all of the State Highway Department of the State of Washington. Such subjects were discussed as: state highway work, materials, engineering features of the construction of the Olympic Loop Highway, and recent developments in pavement construction. Attendance at this meeting was 52.

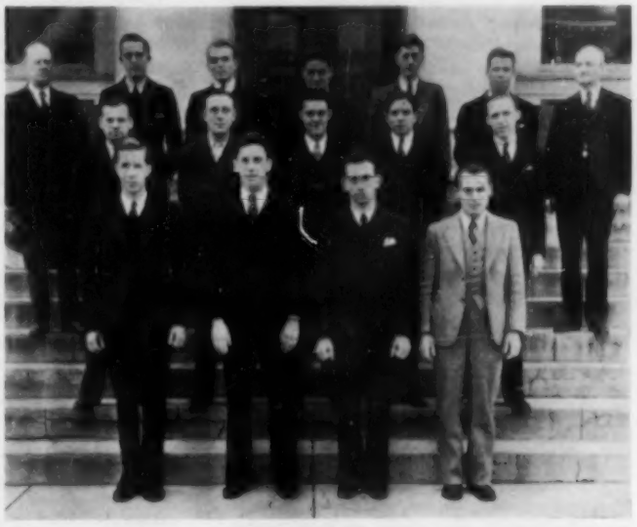
VIRGINIA SECTION

At the annual meeting of the Virginia Section, held on March 25, the following officers were elected for the year 1932: E. M. Hastings, President; J. E. Crawford, J. L. Newcomb, W. T. Howe, and H. G. Shirley, Vice-Presidents; and P. A. Rice, Secretary-Treasurer.

Student Chapter News

CUSTIS LEE ENGINEERING SOCIETY STUDENT CHAPTER

At the meetings of the Custis Lee Engineering Society Student Chapter, held twice each month, papers by the student members are usually read. Occasionally motion picture films of construction work and slides loaned by the Society are shown. The total membership at the present time, including initiates, is 29.



MEMBERS OF THE CUSTIS LEE CHAPTER

OHIO NORTHERN UNIVERSITY STUDENT CHAPTER

On January 14, a meeting of the Chapter was addressed by A. Hawk, who gave a talk on "A Pennsylvania Coal Mine."

The members attended the opening of the Sewage Disposal Plant at Delphos, Ohio, on January 26. The inspection trip was conducted by A. H. Niles, of the Toledo Section.

At their next meeting on February 4, A. R. Webb gave a most interesting talk on "Engineering in the Philippines," and on February 11, slides of the Carquinez Strait Bridge were shown, and a lecture on it read by Herman Lundberg.

OREGON STATE COLLEGE STUDENT CHAPTER

That municipally owned power plants are successful in Oregon, was shown by J. C. Stevens, member of the firm of Stevens and Koon, Consulting Engineers of Portland, at a meeting of the Student Chapter held on March 2. Lantern views were shown to illustrate the talk, which was greatly enjoyed by all present.

VILLANOVA COLLEGE STUDENT CHAPTER

The guest speaker of the February meeting of the Chapter was Prof. C. D. Cook, of the Villanova School of Technology, who gave an interesting address on "The History of the Formation of the World from a Geological Viewpoint."

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for June

DURING THE SUMMER of 1870, D. C. Linsley, locating engineer for the Northern Pacific Railroad, was sent on a confidential reconnaissance of two possible routes over the Cascade Mountains in Washington. With Indians for guides, only hand instruments and a trained eye for observations, a 650-mile exploration was completed in 70 days. From Mr. Linsley's diary, recently discovered in the files of the railroad company, an unusually interesting account of his trip has been prepared for the June issue.

In another article, Frank W. Skinner, M. Am. Soc. C.E., for many years editor of *Engineering Record*, draws from his wealth of experience to trace the development of bridge erection equipment for lifting plate-girder bridges into place. From the wooden gin poles and hand tackle of 1830 to the modern caterpillar crane capable of lifting 100 tons, erection equipment has developed with the increasing lengths and weights of railroad and highway spans.

At the University of Michigan large-scale experiments are being conducted to measure and study the structure of wind gusts. Elaborate equipment electrically records wind velocities and pressures over a wide area. Professors R. H. Sherlock, M. Am. Soc. C.E., and M. B. Stout, who are conducting the tests, have made available their results to date, in an article for the June issue.

On irrigation projects of the Canadian Pacific Railroad, concrete structures have been built with glazed-tile surface facing to protect them from the action of the water. An article by Augustus Griffin, M. Am. Soc. C.E., gives the past experience with this type of construction on Canadian projects.

Other articles will be selected to round out the technical interest of the June issue. In addition there will be included the complete program of the Yellowstone Convention, July 6–9, and other items concerning the activities of the Society.

Determining the Contractor's Responsibility

IN AN EFFORT to make available reliable and unbiased information concerning the past performances and the responsibility of contractors, an organization has been formed, with headquarters in Washington, D.C. The Bureau of Contract Information, Inc., a non-profit-making research corporation, has set itself up as a clearing house for receiving and disseminating such information to responsible persons. Its purpose is to prevent the irresponsible contractor from bidding on construction work.

The information is furnished without cost to officials of proper standing and authority, responsible for the award of contracts. In return, officials are asked to file with the bureau data regarding contracts awarded, the performance of contractors, and notices of defaults and failures. To those who extend credit to the construction industry—manufacturers and distributors of equipment and materials—the information is available on a cost basis. A small uniform fee is charged each contractor who files his own record. Surety companies who write faithful performance bonds are interested in the work of this bureau and contribute to its support.

The first effort to establish such a bureau was made in June 1924, when representatives of various engineering, architectural, contracting, and bonding organizations met in Washington. The bureau is not a part of any existing organization but is conducted to serve the entire construction industry.

A new Directory of Contractors, containing a list of those who have filed performance records with the bureau, has just been completed. It may be obtained free of charge by those responsible for the award of public and private construction contracts by addressing the Bureau of Contract Information, Inc., Munsey Building, Washington, D.C.

New Book on "Hydraulics of Open Channels"

THE SECOND of a series of selected treatises on engineering subjects has been issued in book form by the Engineering Societies Monographs Committee of the four Founder Societies. In 1931, arrangements were made for the publication of books adjudged to possess much usefulness for engineers or industry, but which were not likely to be published commercially because of a too limited sale without special introduction. The first of these monographs, *Plasticity; a Mechanics of the Plastic State of Matter*, by Dr. A. Nadái, was issued last fall and was favorably received.

Now the committee, by arrangement with the McGraw-Hill Book Company, Inc., of New York, has issued *Hydraulics of Open Channels* by Boris A. Bakhmeteff, M. Am. Soc. C.E., Professor at Columbia University and formerly Professor at the Polytechnic Institute, Petrograd, Russia. In this 330-page volume, Professor Bakhmeteff departs from the more rudimentary notion of uniform movement of water flowing in open channels and attempts to present the subject of variable flow in a way that will be useful in engineering practice and design. The hydraulic jump, the theory of varied flow, and its application in designing canals are discussed from the practical point of view. Although much has been written in engineering journals on various phenomena of non-uniform flow, such material is considerably scattered. This volume presents in convenient form much that hitherto has been difficult to find and use, in addition to new material not available elsewhere. The book is available to members of the Society at the special price of $3 if the order is placed before June 1.

Annual Bridge Award Announced

AS HAS been its custom for a number of years, the American Institute of Steel Construction announces its Annual Bridge Award for the most beautiful steel bridges completed during 1931. Entries should be forwarded not later than May 31, as the jury will meet to consider them on June 8.

Three classes of awards are to be made: first, Class A, for structures costing over $1,000,000; second, Class B, for structures costing from $250,000 to $1,000,000; and third, Class C, for structures costing under $250,000. Suitable tablets are to be attached to the winning structures. Owners, engineers, or fabricators are requested to submit as many good photographs as possible of the bridge to be entered, from different points of view, accompanied by information as to the name of the bridge, the location, total cost, engineer, fabricator, owner, date completed and opened to traffic, length of spans, and roadway width.

The first Institute Award for completed bridges was made in 1928. Entries should be forwarded to the Institute at 200 Madison Avenue, New York, N.Y.

NEWS OF ENGINEERS

From Correspondence and Society Files

J. S. PARKER, JR., who was formerly Assistant Engineer for Fuller and McClintock in Philadelphia, is now connected with the Bureau of Water of Reading, Pa.

LLOYD B. SMITH, Chief Engineer for the Smith Concrete Jetty Company in Topeka, Kans., was formerly connected with the Topeka Bridge Company as President and Chief Engineer.

M. M. O'SHAUGHNESSY who, for twenty years, has been City Engineer of San Francisco, has accepted the position of consulting engineer for the Public Utilities Commission of that city.

C. LOOMIS ALLEN, formerly president of Citizens Public Utilities, Inc., in New York City, is now doing some special work for Alfred University in Alfred, N.Y., as chairman of its finance committee.

WILLIAM N. DOWNEY, previously employed by the Cincinnati Union Terminal Company in Cincinnati, is now in Frankfort, Ky., where he is connected with the State Highway Department.

J. Q. A. GREENE, who was secretary of the Gunite Concrete and Construction Company, in Kansas City, Mo., is now vice-president of the same company, located in Chicago, in charge of the Chicago territory.

HENRY N. HAZARD, previously Superintendent of Erection for the Shoemaker Bridge Company in Philadelphia, is now Resident Engineer in the Erection Department of the McClintic-Marshall Company in Pottstown, Pa.

LOUIS E. RYDELL, formerly Designer for the Department of Public Utilities of the City of Tacoma, now has a position with the State Engineer of Oregon.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From March 10 to April 9, 1932

ADDITIONS TO MEMBERSHIP

ALBERT, SIDNEY GUSSMAN (Jun. '31), Research Asst. in Soil Mechanics, Civ. Eng. Dept., Mass. Inst. Tech., Cambridge, Mass.

BARRICK, MERVIN JOSEPH (Assoc. M. '32), Dist. Engr., State Dept. of Health (Res., 724 First Ave.), Williamsport, Pa.

BENNETT, EARL ROBERT (Jun. '31), 5311 Third Ave., Los Angeles, Calif.

BENTLEY, ELROY WILLIS (Assoc. M. '32), Surv., 2 School St. (Res., 79 Park St.), Glen Falls, N.Y.

BETTS, FRANKLIN PERLEY (Jun. '32), 65½ Poningo St., Port Chester, N.Y.

BJORNSTAD, BJARNE THORLEIF (Jun. '31), 104 North 101st St., Seattle, Wash.

BOREHAM, DONALD STEWART (Assoc. M. '32), Asst. Commr. of Public Works, St. Thomas, Virgin Islands.

BRAGONIER, ARTHUR TAYLOR (Assoc. M. '32), Associate Prof., Applied Mechanics, Marshall Coll. (Res., 166 Woodland Drive), Huntington, W.Va.

BROBERG, FREY LORENTS (Assoc. M. '32), 50 West Front St., Red Bank, N.J.

BROOKS, ROBERT MORRIS (Jun. '32), 2500 Battery St., Little Rock, Ark.

BROWNE, HAROLD GEORGE (Jun. '32), 1991 California St., San Francisco, Calif.

BUDD, JOHN MARSHALL (Jun. '32), Asst. to Elec. Engr., G. N. Ry. (Res., 11 Summit Court), St. Paul, Minn.

CARLSON, ALDEN CARL (Jun. '31), 4126 Second Ave., N.W., Seattle, Wash.

CLAUS, WILLIAM GEORGE (Jun. '31), 824 De Camp Ave., Schenectady, N.Y.

DEAN, ARTHUR CRESWELL (M. '32), Cons. Civ. Engr. (C. S. Allott & Son), 1 North Parade, Manchester, England.

DI MICELI, BERNARD JAMES (Jun. '32), Junior Asst. Civ. Engr., Grade 1, Long Island State Park Comm.; 1133 Intervale Ave., New York, N.Y.

EDSTRAND, JOHN PHILIP (Jun. '32), Junior Engr., U.S. Engr. Office, 609 Postal Telegraph Bldg., Kansas City, Mo.

FERNÀNDEZ PERALTA, RICARDO (Assoc. M. '32), Chf. Engr., Comision Especial de Pavimentación y Saneamiento de San José, Apartado 423, San José, Costa Rica.

FUNK, GEORGE JAMES (Jun. '31), Structural Draftsman, Am. Bridge Co., Pencoyd Plant, Philadelphia, Pa.

GARMONG, KARL RICHARD (Jun. '31), 121½ Kent Ave., Terre Haute, Ind.

GRAFF, ALVIN ROBERT (Jun. '31), 133 Coe Ave., Hillside, N.J.

GUYN, JOEL WHITE (M. Feb. '32), City Engr., City Hall, Lexington, Ky.

HANCOCK, CLARENCE COLES (M. '32), Engr. for Roads and Public Works, Expanded Metal Co., Ltd., 243 Abbey House, Westminster, London S.W. 1, England.

HARRISON, ALBERT (Jun. '31), Rodman, State Highway Dept., Benton City, Mo.

HOUSTON, LAWRENCE ANDREW (Jun. '31), Route 2, Enumclaw, Wash.

HUMPHREYS, HOWARD CECIL LEE (M. '32), (Howard Humphreys & Sons), 17 Victoria St., Westminster, London, England.

HUTTON, KENT MAX (Jun. '31), 205 West Main St., Florence, Colo.

JACOBS, ROY KENNETH (Jun. '31), L.B. 114, Continental, Ohio.

JEFFRIES, HERBERT OTTLEY, JR. (Jun. '32), care, Banco Agricola Comercial, San Salvador, Salvador.

JOHANNESSEN, WALTER (Assoc. M. '32), Asst. City Engr. (Res., 1417 East McDowell), Phoenix, Ariz.

JOHANSEN, RALPH STEVENSON (Jun. '31), 158 Bertling Lane, Winnetka, Ill.

JOHNSON, TOM ROYSE (Jun. '31), Draftsman, State Highway Dept.; 847 East Lee St., Tucson, Ariz.

JOHNSTONE, DON (Jun. '32), Surveyman, War Dept., Dist. Engr.'s Office (Res., 2109 East 36th St.), Kansas City, Mo.

JOSEPH, LOUIS SIMMONDS (Assoc. M. '31), Engr., Marcus Contr. Co., Inc., 44 Walton St., Brooklyn (Res., 2541 Whitney St., Astoria), N.Y.

KAHL, FRANK BUDD (Jun. '32), with S. P. & S. Ry. (Res., 305 East 52d St., North), Portland, Ore.

KETTENHOFEN, ARTHUR PETER (Jun. '31), 621 Veronica, East St. Louis, Ill.

KULKA, ERNST ROBERT HANS (Assoc. M. '32), Anton Graff Str. 24, Dresden, Altstadt, Germany.

LOGAN, GLEN EARNEST (Jun. '31), Palo Alto, Calif.

MANIN, HARRY AARON (Jun. '31), 2081 Cruger Ave., New York, N.Y.

MARSH, LLOYD EDWARD (Jun. '31), Post Rd., Southport, Conn.

MELICK, WILLIAM JOHNSTON, JR. (Jun. '32), Junior Engr., Essex County Park Comm., Montclair (Res., 38 Yale St., Maplewood), N.J.

MENDEZ, JOSE HECTOR (Jun. '32), Box 22, Aguadilla, Porto Rico.

METZ, WILLIAM RAYMOND (Assoc. M. '32), Supt. of Streets (Res., 313 North Foothill Rd.), Beverly Hills, Calif.

MILLS, DONALD (Assoc. M. '31), with Dravo Contr. Co., Pittsburgh (Res., 623 Cochran St., Sewickley), Pa.

MONKMAN, GEORGE HUMPHREY NELSON (M. '32), Asst. Engr. of Constr., C. P. Ry., Winnipeg, Man., Canada.

MORRIS, JOHN RYAN (Jun. '31), Highland, Ohio.

MORRIS, WILLARD FRANK (Jun. '32), 1047 Sunbury Rd., Columbus, Ohio.

NEWTON, CHARLIE FRED (Jun. '32), Asst. Engr., James A. Lewis, 910 Title Guarantee Bldg., Birmingham, Ala.

PARKS, LORNE CLEMENT (Jun. '31), care, State Dept. of Highways, New Ulm, Minn.

PAYNE, EUGENE BENNETT (Jun. '31), 6029 Harwood Ave., Oakland, Calif.

PIPPARD, ALFRED JOHN SUTTON (M. '32), Prof., Civ. Eng., Univ. of Bristol, Bristol, England.

RENO, SAMUEL HAROLD (Assoc. M. '32), Maintenance Supt., State Highway Comm., Chanute, Kans.

ROEMER, EDWARD WILLIAM (Assoc. M. '32), Bldg. Commr., City of Boston, 901 City Hall Annex, Boston, Mass.

SALMON, FRED ARCHER, SR. (Assoc. M. '32), Res. Engr., State Highway Dept., Box 104, Eclectic, Ala.

SEAL, BENJAMIN CALLISON (Jun. '31), Y.M.C.A., Rock Island, Ill.

SHELBY, JOE AUBREY (Jun. '31), 1114 West 9th St., Austin, Tex.

SHUTE, JAMES SELDEN (M. '32), Constr. Engr., Dept. of City Transit (Res., 125 West Olney Ave.), Philadelphia, Pa.

SKELTON, RUSSELL ROY (Assoc. M. '32), Asst. Prof., Civ. Eng., Univ. of New Hampshire (Res., Madbury Rd.), Durham, N.H.

SPEH, EARL FREDERICK (M. '32), Chf. Engr. and Supt. of Railways, Tela R.R., Tela Honduras.

STEPHENS, JAMES HUSKEY (Jun. '31), Walhalla, S.C.

STOCKLMEIR, LOUIS (Assoc. M. '31), Engr., Levison Bros., Cupertino, Calif.

SULLIVAN, CLARENCE THIEL (Assoc. M. '32), Constr. Engr., Union Oil Co. (Res., 6339 West 6th St.), Los Angeles, Calif.

TOUSEY, BERTLAND JAY GRANDISON (Jun. '31) 2821 Sixty-second St., S.E., Portland, Ore.

WILBUR, JOHN BENSON (Assoc. M. '32), Instr., Dept. of Civ. Eng., Mass. Inst. Tech., Cambridge, Mass.

WINTER, JOHN EVERETT (Jun. '32), care, Six Companies, Inc., Boulder City, Nev.

YOUNGQUIST, CARL VERNON (Assoc. M. '31), Asst. Engr., U.S. Geological Survey, Water Resources Branch, 404 Eng. Experiment Station, Ohio State Univ., Columbus, Ohio.

MEMBERSHIP TRANSFERS

ARNESON, EDWIN PERCIVAL (Assoc. M. '19; M. '32), Civ. Engr., 418 Gunter Office Bldg., San Antonio, Tex.

BARTON, GEORGE HENRY (Jun. '28; Assoc. M. '32), Dist. Supervisor, Venezuelan Petroleum Co., Apartado 683, Caracas, Venezuela.

COURTENAY, WILLIAM ALOYSIUS, JR. (Assoc. M. '19; M. '32), Borough Engr. of Marcus Hook; Mgr., Constr. Dept., Sun Oil Co., 1608 Walnut St., Philadelphia (Res., 23 Parkway Ave., Chester), Pa.

CURRY, TRUMAN MINOR, JR. (Assoc. M. '30; M. '32), Associate Engr., Nicholas S. Hill, Jr., 112 East 19th St., New York, N.Y.

DAUDT, RALPH BRUÈRE (Assoc. M. '13; M. '32), Vice-Pres. and Chf. Engr., The A. Bentley & Sons Co., 13th and Belmont Sts. (Res., 2629 Robinwood Ave.), Toledo, Ohio.

FRAIVILLIG, LEONARD MARTIN (Jun. '26; Assoc. M. '32), Chf. Draftsman and Designer, Eng. Dept., City of Bethlehem (Res., 313 East Union Boulevard), Bethlehem, Pa.

GARDNER, ARCHIBALD (Assoc. M. '12; M. Jan. '32), Constr. Engr., The A. Bentley & Sons Co., 201 Belmont Ave., Toledo, Ohio.

GENTHON, RENÉ MARIUS (Assoc. M. '24; M. '32), Res. Engr., Geo. A. Johnson, 150 Nassau St., New York, N.Y. (Res., 157 Second St., Clifton, N.J.).

HARMAN, GEORGE SAMUEL (Jun. '26; Assoc. M. '32), Asst. Engr., Playground Comm. of San Francisco, 370 City Hall (Res., 119 Nineteenth Ave.), San Francisco, Calif.

HUFFMAN, THOMAS ELLSWORTH (Assoc. M. '24; M. '32), Div. Engr., State Highway Dept., Box 875, Lufkin, Tex.

JONES, CLARENCE STRAIN (Jun. '14; Assoc. M. '20; M. '32), Asst. Engr., The Missouri Val. Bridge & Iron Co. (Res., 312 Vine St.), Leavenworth, Kans.

KIMBRELL, GEARY (Assoc. M. '19; M. '32), Asst. Bridge and Highway Engr., City of Portland, City Hall (Res., 544 East 57th St., North), Portland, Ore.

KING, TAO (Jun. '12; Assoc. M. '19; M. '32), Chf. Engr., Peiping-Suiyuan Ry., Peiping, China.

MATSUNAYE, WILLIAM SHAW, JR. (Jun. '28; Assoc. M. '31), Junior Asst. Engr., Grade 2, County Engr.'s Office, Port Jefferson (Res., Medford Ave., Medford), N.Y.

MITCHELL, DESSO TWIGG (Jun. '27; Assoc. M. '32), Field Engr., Sewer Dept., Div. of Eng. and Constr., City of Columbus (Res., 1460 Republic Ave.), Columbus, Ohio.

RUBINS, RALPH EDWARD (Jun. '23; Assoc. M. '31), Archt's Supt., Hewitt & Brown, 1200 Second Ave., South, Minneapolis, Minn.

SALSBURY, MARKHAM ELMER (Jun. '27; Assoc. M. '31), Instr. in Hydraulics, School of Citizenship and Public Administration, Univ. of Southern California, Los Angeles (Res., 351 West Marigold St., Pasadena), Calif.

SPROTT, HOWARD JUDSON (Jun. '27; Assoc. M. '31), Asst. Engr., Met. Dist. Water Supply Comm. of Massachusetts, 128 Lexington St., East Boston, Mass.

RESIGNATIONS

ACREE, GEORGE, Jun., resigned Mar. 26, '32.

BOGGS, IRVING HOOK, Assoc. M., resigned Mar. 26, '32.

BROGDEN, VERNON SINGERLAND, Assoc. M., resigned Mar. 9, '32.

HONE, AUGUSTUS CRANE, Assoc. M., resigned Apr. 7, '32.

IMHOFF, JOSEPH JACOB, Jun., resigned Mar. 30, '32.

MILLER, AARON GEORGE, Jun., resigned Mar. 28, '32.

MORIGAKI, KIICHIRO, M., resigned Mar. 28, 1932.

NELSON, ERNEST BENJAMIN, Assoc. M., resigned Mar. 9, '32.

SHOEMAKER, ROBERT COMLY, Jun., resigned Mar. 23, '32.

DEATHS

ARRIGONI, CHELSO LINO. Elected Jun., Dec. 14, 1925; date of death unknown.

BAUM, FRANK GEORGE. Elected Assoc. M., July 9, 1906, M., Oct. 7, 1914; died Mar. 14, 1932.

BEHREND, BERNARD ARTHUR. Elected M., Oct. 5, 1909; died Mar. 25, 1932.

BRADY, SAMUEL DUNLAP. Elected M., Sept. 7, 1904; died May 8, 1931.

BRODIE, HUGH. Elected M., Oct. 14, 1929; died Mar. 19, 1932.

DAGGETT, HERBERT CHAPIN. Elected M., July 10, 1907; died Mar. 17, 1932.

FOUGNER, HERMANN. Elected Assoc. M., Feb. 1, 1905, M., Apr. 17, 1923; died Mar. 9, 1932.

FOWLER, FRANK HOYT. Elected Assoc. M., May 7, 1913, M., May 8, 1922; date of death unknown.

LAVELLE, THOMAS MONAHAN. Elected Assoc. M., Sept. 7, 1904, M., June 30, 1911; died Mar. 6, 1932.

MURPHY, JOSEPH LINCOLN. Elected Assoc. M., May 6, 1914; died Feb. 20, 1932.

RAY, FREDERICK GEORGE. Elected M., Apr. 6, 1909; died Mar. 21, 1932.

ROGERS, EDWIN HENRY. Elected M., Jan. 2, 1907; died Mar. 6, 1932.

SMALL, CHARLES CHURCHILL. Elected M., Dec. 31, 1913; died Apr. 5, 1932.

SPENCER, PAUL BERTRAM. Elected Assoc. M Aug. 31, 1915; died Mar. 26, 1932.

STARRETT, WILLIAM AIKEN. Elected Assoc. M., Oct. 7, 1914, M., Mar. 14, 1916; died Mar. 25, 1932.

THOMPSON, WILLIAM LOVE. Elected M., June 6, 1911; died Feb. 23, 1932.

TOTAL MEMBERSHIP AS OF APRIL 9, 1932

Members	5,867
Associate Members	6,366
Corporate Members	12,233
Honorary Members	18
Juniors	2,921
Affiliates	123
Fellows	5
Total	15,300

Men Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1932 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

Men Available

CONSTRUCTION

CONSTRUCTION ENGINEER AND MANAGER; Assoc. M. Am. Soc. C.E.; 44; married; Cornell graduate; Protestant. Thorough knowledge of building work through 15 years experience as executive, with architects, engineers, contractors, and owners, as superintendent, chief engineer, and construction manager. Qualified to plan, organize, systematize, and execute any building project. C-1409.

CONSTRUCTION ENGINEER AND MANAGER; Assoc. M. Am. Soc. C.E.; 12 years of industrial and commercial construction experience, estimating costs, bidding and closing contracts, purchasing, employing superintendents, and similar work. Construction experience includes: power plants, oil pumping stations and refineries, ice plants, garages, hospitals, hotels, office buildings, and schools. Location immaterial. Available immediately. D-593.

CIVIL ENGINEER, CONSTRUCTION SUPERINTENDENT; Assoc. M. Am. Soc. C.E.; 35; graduate; licensed in New York and New Jersey; experienced in all types of surveys of property, topographical, hydrographical, and development; construction; foundations—power-house, caisson, open and air-underpinning; dredging supervision; municipal engineer on roads, drainage, and water system; airport design and construction. Location immaterial. D-598.

CONSTRUCTION SUPERINTENDENT AND ENGINEER; Assoc. M. Am. Soc. C.E.; 20 years experience on construction of school and monumental buildings, heavy concrete construction, bridges, and foundation work. Has recently specialized in foundation and bridge work, including foundations for large buildings and bridge piers. Thoroughly understands the supervision of heavy equipment, pile driving, cofferdam, concrete work, and general construction. D-261.

CONSTRUCTION ENGINEER AND SUPERINTENDENT; Assoc. M. Am. Soc. C.E.; 47; New York State licensed professional engineer; 23 years valuable experience with contractors and engineers; estimating, plant layouts, purchasing, management, and supervision of construction. Subways, tunnels, underpinning, foundations, grade crossing eliminations, bridges, water works, and sewage disposal plants. B-4680.

ESTIMATOR AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; graduate of Massachusetts Institute of Technology. Desires position with construction or engineering concern, United States or abroad; 12 years practical experience in estimating, designing, and taking care of subcontractors, following up jobs to completion on all types of structures. Intimate knowledge of all phases of construction. Excellent references. B-1168.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; C.E. degree; New York license; 12 years experience in layout and design of industrial plants, copper refineries, smelters, structural work and foundations, heavy machinery and furnaces. Can take charge of drafting room; 6 years experience on construction. Available at once. B-5715.

DESIGN

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; B.S. in civil engineering; 3 years and 9 months experience as structural draftsman on subway and vehicular tunnel drainage work, both concrete and steel design. Pipe layouts and sewer design. Desires permanent position as designer or draftsman with construction company or consulting engineer. D-538.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; 2 years experience in design and drafting of steel and concrete structures for major hydro-electric and steam power projects; 1 year experience in preparation of complete structural and architectural specifications for miscellaneous municipal buildings. Desires position with engineering or contracting firm. Available immediately. D-610.

HYDRAULIC AND DESIGNING ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; graduate; 7 years experience on hydraulic investigations, dam design, and construction. Principal assistant on $2,500,000 irrigation and water supply project; in direct charge of engineering investigations and design of earthen dam, appurtenant works, and pressure distribution system. Desires position in charge of hydraulic investigation, design, and construction of dams. Location immaterial. D-680.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; interested in civil engineering instruction and research; Master's degree in civil engineering from leading engineering college; research experience; 1 year experience teaching civil engineering subjects; 1 year experience on bridge design; 1 year experience on structural steel detailing, surveying, and highway design. Location immaterial. D-661.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 31; married; graduate of Lehigh University, 1924; 1 year at graduate school of University of Illinois; 7½ years broad experience drafting, designing, and estimating departments with fabricators and engineers on bridges and buildings of all types. Desires position as designer, assistant engineer, or sales engineer in steel or reinforced concrete. C-7922.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 31; single; C.E. degree; 5 years as engineer and job superintendent on large public utility and commercial projects; 2 years municipal experience in structural engineering, checking design and inspecting construction on major buildings; 1 year in charge of design, plans, and specifications on parkway structures, principally

skew arches and indeterminate structures. C-9968.

DRAFTSMEN

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single. Experienced structural designer and checker. Good draftsman. D-453.

EXECUTIVE

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E., 30; C.E. degree; 4 dependents; unusual experience in surveying—1 year structural drafting, 2 years designer; 6 years detailed design, stress analysis, following bridge structures; simple spans, cantilevers, arches (steel and concrete), suspension continuous, and rigid frames. Desires position in engineering organization with opportunity to work into firm. Teaching considered. Available immediately. D-716.

STRUCTURAL ENGINEER AND DESIGNER; Assoc. M. Am. Soc. C.E.; 29; married; graduate of Rensselaer Polytechnic Institute; licensed; 9 years experience; 7½ years with consulting engineer—last 2 years in charge of office; design, specifications, estimates, details all types of bridges, especially vertical lift; structural design for buildings. Expert checker of shop drawings. D-506.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; married; graduate with C.E. degree from Massachusetts Institute of Technology; 10 years experience in the design and construction of buildings, power plants, and railroads. Now employed as supervisor on large office building. Desires a permanent connection with a consulting engineer or a large operating company. Preferred location, East or foreign. Available June 1. B-7096.

WATER WORKS ENGINEER OR SUPERINTENDENT; M. Am. Soc. C.E.; 15 years engineering and construction experience as executive of the municipal water department in a city with population of 250,000. Experience in all lines of municipal engineering. Capable of taking responsible charge in a large organization, and of handling both engineering and management of system, including large construction force or supervision of contracts. D-601.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; licensed; 20 years experience, oil and natural gas industry, appraisal reports, and estimation of reserves of natural resources. Expert in mapping and planning projects covering large areas. Location in West preferred. C-7723.

STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 30; has field experience and 9 years drafting and checking experience along mine, mill, smelter, fabricating plant, hydro-electric system, and marine lines. Can estimate and has knowledge of design; has had 3 years service in South America and speaks Spanish. Location and salary open. D-624.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 34; married; graduate. Experienced in construction of water works structures, large mill buildings; 5 years experience in design of bridges, mill buildings, and water supply; also engineer and contractor's superintendent in responsible charge. Capable of handling men. Desires responsible connection with engineer, contractor, or university. Registered in New York and Pennsylvania. D-363.

ENGINEER-EXECUTIVE; M. Am. Soc. C.E.; 50; registered engineer. Broad experience in management, manufacturing, and plant control. Active charge of sales and finances. Experienced in manufacturing castings, boilers, engines, machinery, textiles, structural steel, and all ramifications entering into their manufacture and marketing. American; gentile; graduate engineer. C-1432.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 10 years experience in estimating and designing reinforced concrete, structural steel, and heavy timber construction for cement, sand, gravel, stone, coal, coke, ready-mix concrete, and soda ash storage plants. Also experience on general industrial buildings and highway bridges, including all material-handling equipment. Location in East. Salary open. C-5762.

EXECUTIVE ENGINEER-SALES MANAGER; M. Am. Soc. C.E.; 44; 15 years experience as chief engineer and sales manager of structural steel fabricating company, specializing in directing, supervision of estimating, designing, pricing, and sales of all types of steel structures. Economical design, fabrication, and construction featured. Familiar with arc welding construction; 3 years experience in general contracting business. Desires new permanent connection. C-5095.

CIVIL ENGINEER AND EXECUTIVE; Assoc. M. Am. Soc. C.E.; 35; married; Illinois license; graduate of University of Illinois; 5 years experience as general contractor on water works and sewage disposal plants; 6 years experience in design, construction, and estimating on municipal works and general building construction. Desires connection with responsible firm engaged in engineering or contracting. Will consider moderate starting salary. Location immaterial. D-675.

ENGINEER EXECUTIVE; M. Am. Soc. C.E.; 25 years experience in charge of construction of power houses, dams, canals, and tunnels for large hydro-electric developments and as manager of operating properties. Familiar with, and able to overcome, difficulties and competent to build or direct an organization for this kind of work. D-681.

CIVIL AND INDUSTRIAL ENGINEER; M. Am. Soc. C.E.; graduate; licensed; experienced in organization and supervision of office and field forces. Design and construction of hydro-electric developments, industrial plants, institutional buildings, and housing groups for state and private interests, including sewer and water lines and all other utilities. B-2835.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years structural experience in drafting, design, and construction; estimates, inspection, surveys, layouts, and related work on steel and concrete for railroads, subways, and buildings. Capacity to assume responsibility. Desires connection with construction company, consultant, contractor, or architect in field or office; also sales-engineering or instructorship. C-2605.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E., 41; experience in supervision of design, sales, and estimating of industrial plants. Seeks connection with engineering, contracting, or fabricating firm. D-693.

ENGINEER; Assoc. M. Am. Soc. C.E.; graduate of Massachusetts Institute of Technology. Experience in foreign countries—14 years as resident engineer for steel company; 4 years as engineering representative for paving company. Extensive promotion work with municipalities, engineers, and contractors throughout South America. Speaks Spanish and Portuguese. Open for connection. C-3362.

ENGINEER; M. Am. Soc. C.E.; 41; industrial, mechanical, and construction work. Complete industrial plants and power stations; investigations, reports, planning, design, mechanical, building, construction, operation, selling; justified plant improvements and economic layouts, manufacturing methods, and processes; engineering reports for use in connection with mergers, consolidations, and sale or purchase of industrial and other properties. Satisfactory references. A-1185.

INDUSTRIAL AND FOOD PLANT ENGINEER; Jun. Am. Soc. C.E.; graduate civil engineer; last 4 years assistant chief engineer for large food manufacturing concern. Experienced in construction and operation of steam power plants; electrical generating installations; refrigeration installations; food cooking equipment, both atmospheric and vacuum processes; and spray drying of milk and baby foods. C-3230.

MUNICIPAL AND SANITARY ENGINEER; Jun. Am. Soc. C.E.; 30; married; 6 years experience in office and field work on municipal and sanitary improvement projects; 2 years responsible charge of construction of sanitary structures. Licensed in 2 states. Location immaterial. Available immediately. D-700.

EXECUTIVE CIVIL ENGINEER AND CONSTRUCTION MANAGER; M. Am. Soc. C.E.; 39; graduate and licensed professional engineer; 20 years experience in design, construction, and consultation on bridges, docks, and buildings. Executive manager for past 8 years on large construction projects, including housing and real estate developments. Available for temporary or permanent connection. A-515.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 15 years experience—10 in executive capacities in design and construction, all types of bridges, steel and concrete structures, foundations, and contact and publicity in consulting field. Desires permanent connection with opportunities, preferably in South or Southeast, but will go anywhere. Available on short notice. C-2573.

JUNIOR

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; graduate of Worcester Polytechnic Institute, 1930. At present taking advanced work at University of Wisconsin in hydraulic field; 1 year experience with utility company on hydro-electric construction and investigations. Fine references. Location immaterial. Available June 15. C-8660.

ASSISTANT ENGINEER; Jun. Am. Soc. C.E.; 23; 2 years field and office experience, consisting of property and topographic surveying and map making; soundings and current meter work; construction utility conduit line; park construction; grading, paths, drives, and storm sewers; cost estimates; computations; sewer design; record map making. Desires drafting and design, or construction work. D-631.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; B.S. in C.E. from Rutgers University, 1930; 1½ years experience as transitman for Essex County highway department; passed New Jersey State Civil Service senior draftsman examination. Desires working or teaching position in any branch of civil engineering, preferably one involving mathematics. D-663.

CIVIL AND SANITARY ENGINEER; Jun. Am. Soc. C.E.; 23; at present studying for M.S. in C.E. at Massachusetts Institute of Technology; 2 years experience on highway construction, 16 months as chief of party. Passed U.S. Civil Service examination for junior civil engineer. Desires work in sanitary or civil engineering. Available June 10. D-618.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; civil engineering graduate; 1½ years experience on highway construction, drafting, and design. Desires position in any branch of civil engineering, preferably structural engineering. Location immaterial. Available immediately. D-709.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 22; single; graduate of Rensselaer Polytechnic Institute, 1930; Master's degree, 1931. Desires opportunity in any civil engineering work, field or office, especially structural engineering. Location immaterial. Available at once. References on request. D-718.

GRADUATE CIVIL AND CONSTRUCTION ENGINEER; Jun. Am. Soc. C.E.; 23; graduate of New York University, 1930. Building construction experience; 1 year computer and checker, highway right-of-way department. During past year engineer in charge of large highway and bridge projects. Can work as superintendent, estimator, or foreman. Best references. Available immediately. Location immaterial. D-703.

MISCELLANEOUS

PAPER MILL DESIGNER AND DRAFTSMAN; Assoc. M. Am. Soc. C.E.; 33; married. Graduate civil engineer; 8 years experience in the paper industry; complete design and construction of P. and P. mills. Structural engineer. Speaks Russian. Naturalized. D-119.

STRUCTURAL AND APPRAISAL ENGINEER; M. Am. Soc. C.E.; 43; married; S.M. in C.E.; 3 years experience in bridge design, erection, and inspection; 17 years appraisal work on all classes of property; witness stand experience. Desires position with railroad, consulting engineer, or appraisal company in Metropolitan area. Salary desired $7,200, but might take less. D-758.

RESEARCH

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single; university graduate, 1926; 3 years experience in all phases of concrete production control for highway, building, and hydro-electric construction. Has thorough knowledge of important recent discoveries in concrete research; 2 years experience in highway engineering; 1 year experience in aerial surveying. C-6003.

SALES

CIVIL ENGINEER; M. Am. Soc. C.E.; 39; married; 4 years experience as sales engineer of highway and irrigation materials; 5 years highway research, testing, and construction; 2 years on irrigation surveys and construction. Available immediately. Location Northwest or foreign. D-642-323-A-8 San Francisco.

SALES ENGINEER; Assoc. M. Am. Soc. C.E.; university graduate; 10 years industrial work and structural design; 10 years sales work. Splendid experience in the national marketing of steel joists and welded steel products; capable district manager. Excellent health, good executive, productive salesman, and hard worker. Wants connection. Location immaterial. D-638.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E., 8 years experience in steel and concrete design, supervision, and inspection. From 1929 to date, sales engineer for manufacturer of building product. Has wide acquaintance among architects and general contractors. Desires to represent manufacturer of standard building material in Metropolitan district or in southern New England. A-5435.

STRUCTURAL AND SALES ENGINEER; Assoc. M. Am. Soc. C.E.; 38; married; graduate; over 12 years experience in sales and sales management. Executive ability. Experience in designing, detailing, and estimating of bridges and buildings, specializing in steel. Desires position with building material manufacturer or general contractor. Available immediately. Capable and forceful. D-16.

TEACHING

CIVIL ENGINEER; Jun. Am. Soc. C.E.; member S.P.E.E.; B.S. in C.E.; some work on M.S. completed; experience includes 5 years teaching, 4 years surveying, design, and construction work. Good draftsman. Open for civil engineering work or teaching civil engineering or applied mechanics. C-9051.

ASSOCIATE PROFESSOR STRUCTURAL ENGINEERING; Assoc. M. Am. Soc. C.E.; married; B.S., M.S., C.E. degrees, University of Illinois; 3 years experience teaching major courses, structural theory and design in ranking university; 5 years practice on reinforced concrete and steel structures, chiefly with Waddell and Hardesty, consultants; cantilever, arch, suspension, movable, continuous-girder spans; technical writer; world-traveler. Desires position with a leading university. D-330.

PROFESSOR OF CIVIL ENGINEERING; M. Am. Soc. C.E.; American-born; Presbyterian; Ph.B., B.S., M.S., and C.E.; open for position teaching civil engineering courses other than sanitary; preferably mechanics, structures, or highways; 20 years technical and administrative engineering experience; 4 years teaching. Qualified personally. B-5954.

PROFESSOR OF CIVIL ENGINEERING; M. Am. Soc. C.E.; married; B.C.E., M.Sc., and C.E.; degrees of Ph.D. and Eng.D. to be awarded at close of current school year; prominent professional practice; technical writer; numerous extra-curricular interests; personality; best references; open for any position, teaching professional C.E. subjects, theoretical or experimental research, mathematics, and mechanics—applied or other, and testing of materials. D-635.

GRADUATE; Jun. Am. Soc. C.E.; unmarried; C.E. degree from the Michigan College of Mining and Technology; specialized in hydraulics, water power, and highway engineering. Practical experience with Michigan State Highway Department on construction, survey, and inspection work. Survey experience on transmission lines and on flow lines for power sites. Desires teaching position in technical school. D-515.

INSTRUCTOR; Jun. Am. Soc. C.E.; 27; C.E. degree from Lehigh University; 2 years experience as assistant in mathematics and instructor in surveying theory and practice; 2 years mechanical and electrical experience with public utility; 4 years field and office experience with major engineering company on railroads and steel mills. D-658.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; university graduate. Experience includes one year teaching engineering subjects in university; 12 years experience on railway location, construction, and maintenance, and highway, bridge, sewerage, and building construction. Desires teaching position in university or engineering college. Has certificate in mathematics. Can furnish best references. C-9024.

REGISTERED CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; M.S. at Massachusetts Institute of Technology; 1 year experience surveying; 3½ years experience in city engineer's office; testing and conducting engineering investigations connected with design and construction of sewers, pavements, and airport. Research worker and author. Formerly student assistant teaching surveying field work; competent to teach mathematical or professional subjects. C-6090.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 38; married; degree of C.E. from Swiss Polytechnic University; majored in bridges; citizen; some teaching experience; 9 years experience consulting and designing with foremost American concern. Extensive experience on indeterminate structures. Interested in teaching statics, graphic statics, statically indeterminate systems, bridges, and foundations. Fluent French and German. B-5176.

DIRECTOR OF ENGINEERING AND PROFESSOR OF CIVIL ENGINEERING; M. Am. Soc. C.E.; graduate of Massachusetts Institute of Technology, 1913; engineering administration and highway engineering courses, 1922. Experience as construction, designing, municipal, and consulting engineer. Formerly assistant professor of civil engineering and instructor in Eastern and Middle-Western colleges; 15 years practical engineering experience. Professional or teaching position desired. B-6574.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1932. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

BRIDGES OF THE RHINE: MEDIEVAL, AND MODERN. By K. Möhringer. Messkirch, Baden, Germany, Joh. Möhringer Verlag, 1931. 104 pp., illus., diagrs., maps, tables, 12 × 9 in., cloth, $6.

Starting at Lake Constance, the author presents, in the first part of this interesting work, photographs and brief descriptions of the Rhine bridges. In the second part, five of the most recent bridges are described at length. The first part will interest the student of Bridge history and esthetics, as it gives a panorama of changing types. The second section is valuable as a description of present European practice. The description of the Cologne-Mülheim Bridge, finished in 1929, is especially complete. The illustrations are excellent.

ELEMENTS OF CURVE DESIGN FOR ROAD, RAILWAY, AND RACING TRACK. By F. G. Royal-Dawson. London, E. & F. N. Spon, Ltd., New York, Spon & Chamberlain, 1932. 230 pp., diagrs., tables, 8 × 5 in., cloth, $3.

A comprehensive study of methods of curve alignment which emphasizes the need for transition curves on roads and the necessity for differentiation between roads and railroads in regard to the easement of curves and superelevation. The theory of the transition curve is explained in full, and its application to varied problems is illustrated.

ENGLISCH - DEUTSCHE GEOLOGISCH - MINERALOGISCHE TERMINOLOGIE. By W. R. Jones and A. Cissarz. London, Thomas Murby & Co.; New York, D. Van Nostrand Co., 1931. 250 pp., diagrs., 9 × 6 in., cloth, 12s. 6d.

This book is designed to aid the student who has an elementary knowledge of German to become familiar with the principal terms used in geology, including mineralogy, petrology, and mineral deposits. The chief terms used in English are presented in an explanatory text. Arranged side by side with this is a corresponding German text which is a close translation of it. Appendixes give tables of abbreviations and minerals, with their equivalents, and German and English indexes. This book will be of great value to every engineer interested in German geological publications.

FIRST INTERNATIONAL CONGRESS FOR CONCRETE AND REINFORCED CONCRETE. Liége and Paris, La Technique des Travaux, 1932. Vol. 1, 549 pp., vol. 2, 400 pp., illus., diagrs., charts, tables, 13 × 10 in., paper, 70 Belgas, $10.

The volumes contain the reports presented at Liége in 1930, with minutes of the technical proceedings, the general reports, and the discussions. The following seven questions were discussed: hooped concrete; the theoretical and experimental study of reinforced concrete roofs, slabs, and large domes; important concrete and reinforced concrete structures; shrinkage and thermal variations in concrete and reinforced concrete; concrete and reinforced concrete architecture; the composition, manufacture, and utilization of concrete and reinforced concrete in the yard; pre-cast concrete; and the use of concrete and reinforced concrete in the Colonies. The individual papers are in English, German, or French.

GENERAL ENGINEERING HANDBOOK. Edited by C. E. O'Rourke and Others. New York, McGraw-Hill Book Co., 1932. 921 pp., diagrs., charts, tables, 8 × 5 in., leather, $4.

In preparing this compendium of engineering data, the compilers have attempted to compress the important fundamentals of the various branches of engineering into a single small volume which will supplement detailed handbooks. The work is divided into thirty-one sections, of which six are devoted to subjects of interest to all engineers—mathematics, weights and measures, materials, mechanics, hydraulics, and graphic statics. The remainder treat the major branches of civil, mechanical, and electrical engineering. Each section is prepared by an expert in its field.

MANUAL OF ELECTRIC ARC WELDING. By E. H. Hubert, Ed. New York and London, McGraw-Hill Book Co., 1932. 163 pp., illus., diagrs., tables, 9 × 6 in., cloth, $2.

This book explains the fundamentals of arc-welding processes, gives practical suggestions for performing various welding operations, and enumerates many uses of arc welding. The directions are clear and full, and the book presents the main facts that welders and engineers should know. The publication is sponsored by the welding section of the National Electrical Manufacturers' Association.

TEXTBOOK ON ROOFS AND BRIDGES. Part 2, Graphic Statics. 5 ed. By M. Merriman and H. S. Jacoby; revised by E. E. Ebling. New York, John Wiley & Sons, 1932. 228 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.25.

In preparing the new edition of this well known textbook upon the determination of stresses by graphic methods, the entire work has been rewritten. Obsolete examples and illustrations have been replaced by modern ones. Information has been added about transverse bents and viaduct towers, and an entirely graphic method for the construction of influence lines in simple bridge trusses is given.

WORKING FOR THE SOVIETS—AN AMERICAN ENGINEER IN RUSSIA. By W. A. Rukeyser. New York, Covici Friede, 1932. 286 pp., illus., 8 × 6 in., cloth, $3.

A first-hand description of industrial conditions by an American mining engineer. The author's work for the Soviet government took him to the asbestos mines of western Siberia, with no companions except Russians. He had unusual opportunities to know them and to learn what they thought and how they lived. He gives an interesting account of his experiences.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

BASCULE. Erecting 3,800-Ton Bascules in Arlington Bridge, R. S. Foulds. *Eng. News-Rec.*, vol. 108, no. 9, Mar. 3, 1932, pp. 318 and 319. Engineering features and architectural treatment of two bascule leaves 180 ft. long and 96 ft. wide.

CANADA. Norwood and Main Street Bridges, A. J. Taunton. *Can. Engr.*, vol. 62, no. 10, Mar. 8, 1932, pp. 6–8 and 43. Design and construction of two steel-girder bridges over the Red and Assiniboine rivers between Winnipeg and St. Boniface, Man.; Norwood Bridge has four spans, each 103 ft., and one bascule lift having a clear span of 80 ft.; Main Street Bridge has three spans of approximately 85 ft. between centers of piers and one at the south end, 112 ft. long.

COMBINED, SAN FRANCISCO BAY. San Francisco-Oakland Bay Bridge. *West. Construction News*, vol. 7, no. 4, Feb. 25, 1932, pp. 105–110. Features of the project for bridging San Francisco Bay by a series of two-deck structures totaling 8 miles in length; progress on preliminary studies, foundation explorations, and bridge layouts for $75,000,000 project involving unprecedented design conditions.

CONCRETE, DESIGN. Relationship Between Highway and Bridge Design, C. S. Chettoe and H. C. Adams. *Roads and Road Construction*, vol. 10, no. 110, Feb. 1, 1932, pp. 36–38. Curves for evaluating fiber stresses in section of reinforced concrete subjected to bending and direct compression.

CONCRETE GIRDER. Bridge on North Orbital Road, near St. Albans. *Concrete and Constr. Eng.*, vol. 27, no. 3, Mar. 1932, pp. 151–154. Construction of a railroad crossing bridge 70 ft. wide, consisting of three 26½-ft. spans; details of pre-cast concrete girders simply supported, also of rusticated and other types of joints.

CONSTRUCTION. Modern Methods of Steel Bridge Manufacture, J. Thomson. *Machinery Market*, no. 1633 and 1634, Feb. 19, 1932, pp. 15 and 16, and Feb. 26, p. 15. Feb 19: Accuracy of drawings; straightening sawing and shearing; plate edge planing; cross-wise tests; drilling; complete shop assembly; floating caissons. Feb. 26: Jigs; closing rivets; contraction of rivets; smithwork. Before Inst. Engrs. and Shipbuilders in Scotland.

DESIGN. Statics and Dynamics of Metal Railway and Road Bridges, A. Vierendeel. *Int. Ry. Congress Ass'n—Bul.*, vol. 13, no. 12, Dec. 1931, pp. 1003–1026. General theoretical calculations which bring out the principle factors influencing value of dynamic coefficient; vertical centrifugal forces; shocks and vibrations; experiments; resonance; examination of bridges for soundness.

EXPANSION JOINTS. Survey of Expansion-Joint Practice in Reinforced-Concrete Arch Bridges, E. K. Timby. *Eng. News-Rec.*, vol. 108, no. 11, Mar. 17, 1932, p. 392. Analysis of thirty-six replies received in answer to a questionnaire on expansion-joint practice for reinforced-concrete arch bridges, where floor load is transferred to arch by spandrel columns or by transverse spandrel walls.

GREAT BRITAIN. Steel Arches Replace Three-Span Suspension Bridge Over Thames. *Eng. News-Rec.*, vol. 108, no. 13, Mar. 31, 1932, pp. 480 and 481. Demolition of suspension bridge 65 years old near Lambeth Palace and substitution of a modern steel-arch structure, consisting of five spans—center span of 165 ft., intermediate spans of 149 ft., and shore spans of 125 ft.; building new foundations; superstructure erection.

HIGHWAY, NEW YORK. The Triborough Bridge, E. A. Byrne. *Mun. Engrs. Journal*, vol. 17, paper no. 163, fourth quarterly issue 1931, pp. 121–138, and discussion 138–148. History and outline of Triborough Bridge Project, New York City.

MASSACHUSETTS. Floor Placed First in Erecting Large Steel Arch. *Eng. News-Rec.*, vol. 108, no. 10, Mar. 10, 1932, pp. 358–360. Design and construction of two-hinged, braced steel arch of 547-ft. span with two 20-ft. deep parabolic parallel-chord truss ribs of 34 panels, over the Merrimack River, north of Lowell, Mass. Floor steel was laid on timber falsework and arch trusses were then erected, utilizing hangers as posts.

OKLAHOMA. Need for Speed with Economy Governs Santa Fe Bridge Design, T. Doll. *Eng. News-Rec.*, vol. 108, no. 12, Mar. 24, 1932, pp. 436–439. Canadian River Bridge of the Santa Fe Railway from Amarillo, Tex., to Boise City, Okla., has four deck-truss spans carried by towers of the unusual length of 100 ft.; construction of caissons sunk by open dredging and pneumatic system; concrete work; erecting bridge steel; truss-span erection.

RAILROAD CROSSINGS, GREAT BRITAIN. New Railway Bridge Over North Circular Road. *Engineer*, vol. 153, no. 3970, Feb. 12, 1932, pp. 178–180. The bridge is in two parts, one carrying railroad lines of steel, the other of concrete; the span of the steel bridge is 70 ft. on square; total length is 366 ft.; superstructure of metal parts is built up of longitudinal steel girders and steel decking for a length of 130 ft., while for a length of 232 ft. the superstructure is concrete arch.

SUSPENSION, MAINE. Building First Long-Span Bridge in Maine, D. B. Steinman and C. H. Gronquist. *Eng. News-Rec.*, vol. 108, no. 11, Mar. 17, 1932, pp. 386 and 389. Design and construction of Waldo-Hancock Bridge, spanning main channel of Penobscot River near Bucksport, Me.; main span 800 ft.; bridge features twisted-wire strand cables, Vierendeel-truss-type towers, and continuous girder approaches; footbridges used for cable erection.

VIADUCTS, STEEL. Construction of Over-Crossing on Steel Piles, M. S. Farwell. *Eng. News-Rec.*, vol. 108, no. 13, Mar. 31, 1932, pp. 463 and 464. Design and construction of Bradley overcrossing, near Merced, Calif.; 1,380 ft. long, built on H-piles, tested for 30-ton capacity, H-columns extending directly into ground as bearing piles; structure built by use of welded construction exclusively.

BUILDINGS

DESIGN. Modern Developments in Surface Treatment, H. Davies. *Structural Engr.*, vol. 10, no. 3, Mar. 1932, pp. 127–137. Principles of esthetic treatment of surfaces of buildings; traditional surface treatment; esthetics of concrete surface; function of surface; Romans as concrete builders; modern concrete surfacing; rendered surfaces; concrete slab surfaces; sprayed surfaces; attached surfaces; surfaces and floodlighting.

STADIUMS, COVERED. Structural Design and Erection of Maple Leaf Gardens, Toronto, Ont., G. Townsend and C. W. Power. *Eng. Journal*, vol. 15, no. 3, Mar. 1932, pp. 135–144. Design and construction of hockey arena with a maximum seating capacity of 17,000; absence of columns possible through use of domed roof, comprising two three-hinged arch ribs spanning rectangle on 306-ft. diagonals; structure is tied together by horizontal trusses which support rafters carrying steel deck roof; dimensions are 350 by 282 ft.; height 146 ft.

CITY AND REGIONAL PLANNING

CITY DEVELOPMENT. Crouped vs. Ribbon Forms of Development, E. Unwin. *Surveyor*, vol. 81, no. 2091, Feb. 19, 1932, pp. 247–248. Comparative costs; by-passing the by-passes; development by cul-de-sac; grouped development; ribbon development.

ECONOMIES. Regional Planning and Economy, T. Adams. *Surveyor*, vol. 81, no. 2090, Feb. 12, 1932, pp. 219 and 220. Direct economies from planning; scope of planning; financial benefits; prospective industrial growth.

CONCRETE

AGGREGATES. Review of Research in Concrete Aggregates in 1931, E. Shaw. *Rock Products*, vol. 35, no. 1, Jan. 9, 1932, pp. 107–109. Brief notes on outstanding research results and technical papers published during the year; testing for soundness; research on durability; proportioning materials; grading of aggregates; characteristics of aggregates; types of aggregate; foreign research. Bibliography.

ARCHES. Plain and Reinforced Concrete Arches, C. S. Whitney. *Am. Concrete Inst.—Journal*, vol. 3, no. 7, Mar. 1932, pp. 479–519. Progress report on limitations of theory of elasticity; effect of plastic flow, shrinkage, and temperature variations; Freyssinet method of adjustment. Bibliography.

BEAMS. Effect of Type of Breaking Machine on Modulus of Rupture of 6 by 6-in. Concrete Beams, O. K. Normann. *Pub. Roads*, vol. 12, no. 12, Feb. 1932, pp. 303–308. Tests made with three types of breaking machine; cantilever apparatus; multiple-lever testing machines; improved single-lever field machine.

DESIGN. Cutting Corners in Concrete Structural Design—V, J. R. Goetz. *Concrete*, vol. 40, no. 3, Mar. 1932, pp. 29 and 30. Slab thickness, steel reinforcement, and distribution of loading in two-way slabs; concrete stairs.

MIXING. Higher Unit Stresses in Concrete, A. H. Munro and J. D. Sutherland. *Commonwealth Engr.*, vol. 19, no. 7, Feb. 1, 1932, pp. 245–249. Practice of Melbourne city council as to water-cement ratio-time of mixing and control; grading curve for aggregates; results of various methods of control.

PLANTS, NEW YORK. New Batching Plant in Brooklyn Uses Automatic Control. *Pit and Quarry*, vol. 23, no. 8, Jan. 13, 1932, pp. 45–48 and 89. Use of photo-electric cells in new central-batching plant of the Cranford Material Corp., in Brooklyn, N.Y.; arrangement of aggregate and cement-handling facilities; delivering concrete for subway construction.

RAILROAD CONSTRUCTION. Manufacture of Pre-Cast Reinforced Concrete Parts on Belgian National Railway Company, V. Lemaire and J. Schotte. *Int. Ry. Congress Ass'n—Bul.*, vol. 14, no. 2, Feb. 1932, pp. 103–125. List of uses of either plain or reinforced concrete; raw materials specification and quality required; granulometric sizes of inert materials; results of concrete compression tests; molds and manufactured parts; manufacture, transport, and use of concrete.

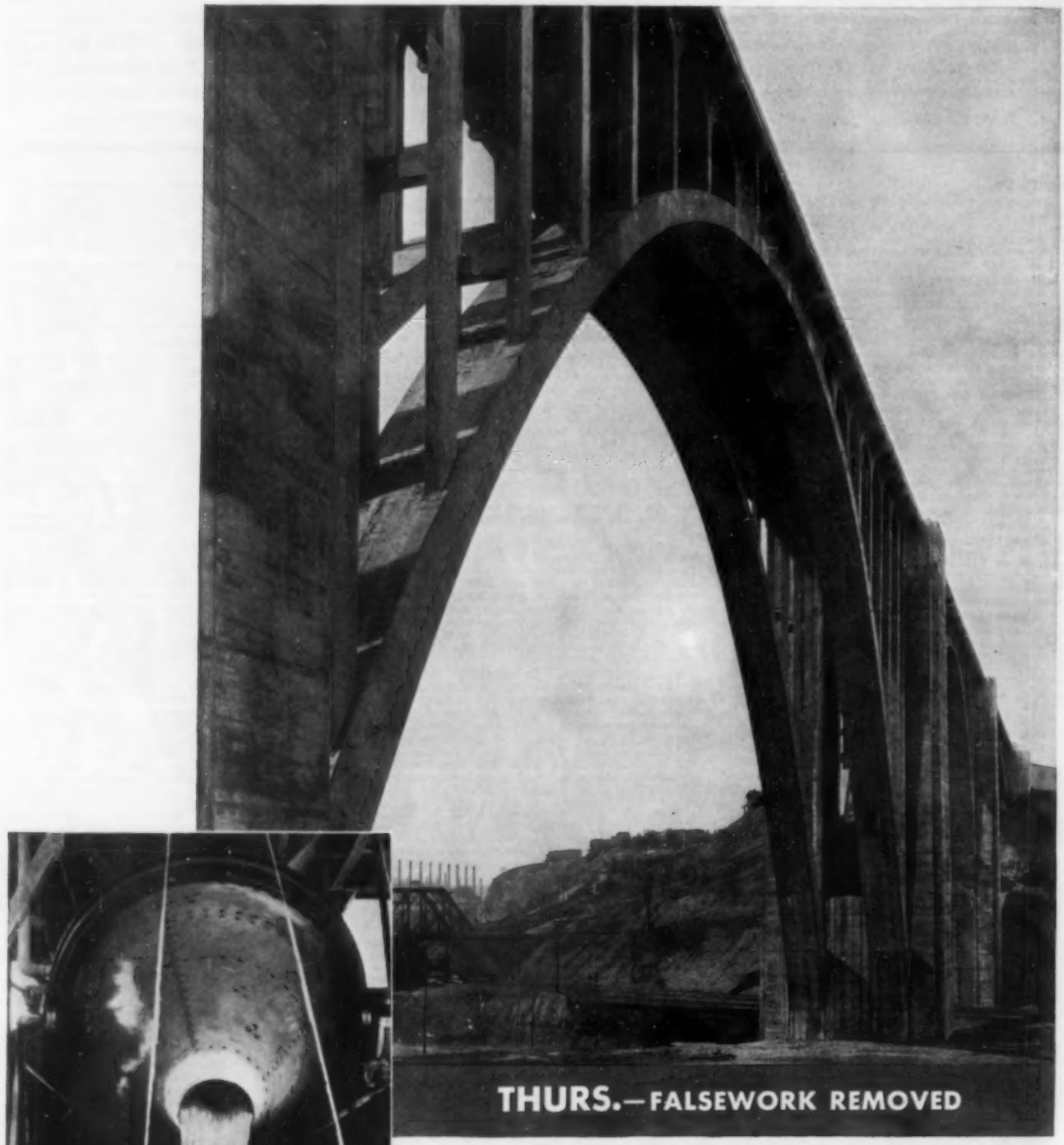
READY-MIXED, UNITED STATES. Technical Activities of National Ready-Mixed Concrete Association, S. Walker. *Rock Products*, vol. 35, no. 1, Jan. 9, 1932, pp. 141–143. Review by association's director of engineering; purchase specifications for ready-mixed concrete; publications; uniformity of strength; design of proportions; methods of sampling; length of haul; time of mixing; estimating quantities; and studies of equipment.

ROADS AND STREETS. Progress in Use of Pre-Mixed Concrete in Highway Building Reported. *Pit and Quarry*, vol. 23, no. 12, Mar. 9, 1932, pp. 43 and 44. Report on central and truck-mixed concrete presented at the 1931 convention of the American Road Builders' Ass'n; improved type of equipment for transfer of material to subgrade; lack of control.

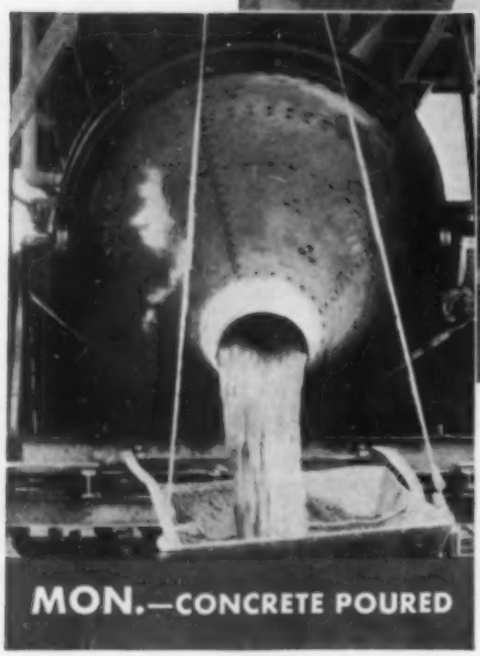
SHALE. Shale in Aggregates, E. F. Bean. *Nat. Sand and Gravel—Bul.*, vol. 13, no. 1, Jan. 15, 1932, pp. 13–15 and 20; see also *Crushed Stone Journal*, vol. 8, no. 1, Jan. 1932, pp. 7–9. Origin and characteristics of shale and its metamorphic equivalents from the standpoint of highway aggregates; shales, slates, phyllites and mica schists can be derived from clay by progressive metamorphism; weathering; shales in aggregates; slates and schists as aggregates.

SPECIFICATIONS. Some Comments on Aggregate Specifications, H. S. Mattimore. *Nat. Sand and Gravel Bul.*, vol. 13, no. 2, Feb. 15, 1932, pp. 35 and 36. Procedure and process of drawing specifications; weakness of specifications; where producer can assist consumer in formulating specifications; uses for gravel aggregate. Before Nat. Sand and Gravel Ass'n.

100 Days Gained on



THURS.—FALSEWORK REMOVED



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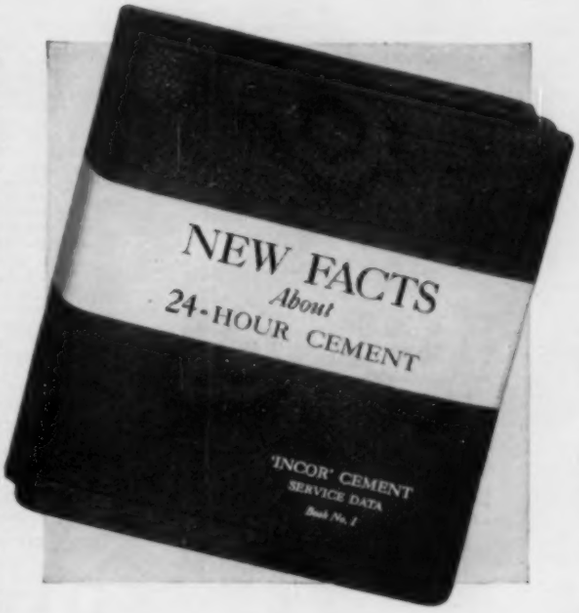

$1,520,000 Spent to Save $436,192 Yearly

The George Westinghouse Bridge (named in honor of the inventor, whose factories lie in the valley) is a 5-span, open spandrel arch structure, 1520 feet long. The 460-foot center span is the longest concrete arch in America.

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Pouring operations were planned to give symmetrical loading and avoid distortion of arch centers, 5 keyways being left in each rib.

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TANKS. Estimating Steel Quantities in Circular Tanks, H. Carpenter. *Concrete and Constr. Engr.*, vol. 27, no. 2, Feb. 1932, pp. 101–103. Outline of a short method of determining quantities of reinforcement in circular tanks.

CONSTRUCTION INDUSTRY

COSTS. Current Construction Unit Prices. *Eng. News-Rec.*, vol. 108, no. 8, Feb. 25, 1932, p. 296. Unit cost bid on dredging in Miami River, Fla.; concrete sewers of special section in Milwaukee, and aeration and settling tanks for Cleveland.

FOUNDATIONS, CONSTRUCTION. Shovels Load Trucks at Bottom of 70-Ft. Hole. *Construction Methods*, vol. 14, no. 3, Mar. 1932, pp. 24–26. Rock excavation to a depth of 70 ft. below street level, for first unit of the Metropolitan Life Insurance Company's home-office group of buildings in New York City; field test of experimental equipment to eliminate dust evil in drilling; use of electric elevator, to a depth of 38 ft. below street level, and steep ramp equipped with booster hoist, leading to this elevator, to load trucks on bottom of excavation.

DAMS

CONCRETE, CONSTRUCTION. Apply Modern Construction Methods on Wilmington Dam, R. P. Brown. *Concrete*, vol. 40, no. 3, Mar. 1932, pp. 7–9. Construction of concrete dam, 110 ft. high, for Wilmington, Del., water works; 150,000 barrels of cement were pumped to construction site from special bulk cement railway cars; concrete distributed by continuous belt conveyors.

DESIGN. Economies in Dams Designed for Increase in Height, C. V. Davis. *Eng. News-Rec.*, vol. 108, no. 8, Feb. 25, 1932, pp. 292 and 293. Theoretical analysis showing that designing and building foundations and substructures of dams, with provisions for adding to their height in the future, lead to major economies when increased capacity is needed; trajectories of principal stresses in gravity dam; forces determining stability of downstream column.

GRAVITY, CONSTRUCTION. Concrete Plant for Cauvery Metur Dam. *Engineer*, vol. 153, no. 3969, Feb. 5, 1932, pp. 158 and 160. Plants supplied by Hadfields, Ltd., include sledging breaker, of which flywheel turns at 150 r.p.m; blocks of granite weighing as much as 2 tons can be crushed by this breaker, and delivered as 6 to 8-in. cubes; breaker delivers granite on to conveyor fitted with trays 30 in. wide and 8 in. deep.

INDIA. Metur Dam, Madras. *Engineering*, vol. 133, no. 3450 and 3452, Feb. 26, 1932, pp. 238–241 and Mar. 11, pp. 301 and 302. Maximum height of dam above deepest foundations is 230 ft.; cubical contents amount to 54,000,000 cu. ft.; length 5,300 ft.; surface of impounded water at normal full level will be 59¼ square miles; capacity of reservoir is 93,500,000,000 cu. ft.; design and constructional details.

MOVABLE. Roof-Weir Dam on Guadalupe River, Texas, H. B. M. Stevenson. *West Construction News*, vol. 7, no. 5, Mar. 10, 1932, pp. 137–139. Design and construction of movable steel-roof dam, resembling Swiss patented type, for Texas Hydro-Electric Corporation, 12 miles northwest of Gonzales; height of dam to maximum lift of roof weirs is 33 ft.; contract price $305,000.

OUTLETS. Control of Water Through Dams and Pressure Tunnels, E. B. Ball. *Civ. Eng.* (*Lond.*), vol. 26, no. 308, Feb. 1932, pp. 29–32. Recent developments in control apparatus for dealing with water in large volumes and under high velocity of discharges; jet dispersers; sluice gates; sluice valves; balanced disc valves; needle valves; spectacle eye valves; rotary valves; control apparatus for pressure and division tunnels; emergency closing devices; free roller emergency gates. Before Inst. of Mech. Engrs.

SPILLWAYS, DESIGN. Graphical Analysis of Spillway Capacity, E. J. Bednarski. *West Construction News*, vol. 7, no. 4, Feb. 25, 1932, pp. 113–115. Outline of graphical method of finding maximum elevation to which water may rise during maximum inflow.

UNITED STATES. Dams—High, Large, and Unusual—II, F. I. Taylor. *Reclamation Era*, vol. 23, no. 3, Mar. 1932, pp. 58–60. Power dams; flood-control dams; Texas earth dams; largest dams; how high is a dam? Table of largest dams in United States and possessions.

FLOOD CONTROL

NEW ENGLAND. Relation of Forests to Water Supplies of New England, C. E. Behre. *Water Works Eng.*, vol. 85, no. 5, Mar. 9, 1932, pp. 276 and 279. Effect of forest lands in Eastern States, on floods, streamflow, erosion, and problems of water supply. What may be done by research. Before New England Water Works Ass'n.

REFORESTATION. National Aspects of Soil Erosion and Floods and Their Control by Vegetative Cover, S. Leavitt. *Journal Forestry*, vol. 30, no. 3, Mar. 1932, pp. 328–335. Agricultural, industrial, and social losses that result from erosion and floods; control of floods; relation of forests and other vegetative cover to control of floods, erosion, and water resources.

FLOW OF FLUIDS

CRITICAL DEPTH. Critical Depth in Non-Uniform Flow, G. S. Coleman. *Water and Water Eng.*, vol. 34, no. 401, Mar. 21, 1932, pp. 127 and 128 and 130–131. Theoretical mathematical discussion and results of 600 experimental tests made in the laboratory of Victoria University, in Manchester.

FOUNDATIONS

BUILDINGS. Foundation Methods on New Orleans Department Store Construction. *Gen. Bldg. Contractor*, vol. 3, no. 3, Mar. 1932, pp. 9–13. Method of excavating foundation from center outward, for 5-story department store occupying an area of 200 ft. by 100 ft.

CONCRETE. Spread Footings, Mat Foundations, and Deep Foundations, R. H. Vose. *Concrete*, vol. 40, no. 3, Mar. 1932, pp. 21–23. Testing, inspection, and field supervision of footings and foundations; concrete piles and caisson piers; advantages and limitations of cast-in-place and pre-cast piles.

DRIVING. Test Results from Driving of Reinforced Concrete Piles 100 Feet in Length, A. Moller. *Civ. Eng.* (*Lond.*), vol. 26, no. 308, Feb. 1932, pp. 24–25. Description of method of driving hollow reinforced concrete pile practiced in construction of foundations for new highway bridge over Limfjord, at Aalborg, Denmark; details of pile 100 ft. long, with circular cross section; outer diameter 26 in.; inner diameter 20 in.; core consists of welded steel tube made of 14-gage plate; load testing.

EARTH PRESSURE. Experiments on Earth Pressure, M. L. Ravier. *Civ. Eng.* (*Lond.*), vol. 26, no. 308, Feb. 1932, pp. 53–57 (discussion) 57–59. Discussion of original experiments with models; conclusions as to construction of quay walls; design of compound hollow-block quay; compound quay on piers. Read at a meeting of the British Section of Societe des Ingenieurs Civils de France.

PILES. Hollow Concrete Piles Made by Centrifugal Process, L. R. Need. *Eng. News-Rec.*, vol. 108, no. 10, Mar. 10, 1932, pp. 374 and 375. Manufacture of hollow reinforced-concrete piles by Westinghouse Electric & Manufacturing Co.; dense concrete of high compressive strength obtained by spinning piles for fifteen minutes; tests.

PRESSURE. Pressure under Raft Foundations, A. C. Vivian. *Civ. Eng.* (*Lond.*), vol. 26, no. 308, Feb. 1932, pp. 17–20. Rapid method of calculating maximum earth pressure which can occur under raft foundations of square or rectangular, circular or hexagonal shapes; method applies to rafts of any size and is of particular use when vertical load carried by raft is transmitted to soft subsoil and is displaced (by reason of wind pressure on superstructure or any other cause) from center of area of raft.

TESTING. Lateral Clay-Pressure Phenomena in Detroit Foundation, J. R. James. *Eng. News-Rec.*, vol. 108, no. 13, Mar. 31, 1932, pp. 479 and 480. Goldbeck cells in caisson walls disclose eccentric and also unexpectedly great lateral pressures in constructing the Delray power-house foundations in Detroit clay; caisson plan; new construction methods.

WASHINGTON, D.C. New System of Driving Piling. *Constructor*, vol. 14, no. 3, Mar. 1932, pp. 16 and 17. System of pouring and driving pre-cast round piling in preparing the foundations of the new Department of Justice Building, in Washington, D.C.

WOODEN. Creosoted Piles Good as New After 13 to 21 Years Use. *Eng. News-Rec.*, vol. 108, no. 10, Mar. 10, 1932, p. 353. Piles driven in 1911 for turn-table foundation, at Champaign, Ill., in sandy clay alternately wet and dry, exposed for examination in October 1931, show long life; city building codes should distinguish between treated and untreated piles.

HYDRAULIC ENGINEERING

LABORATORIES, UNITED STATES. National Hydraulic Laboratory Will Expedite Research, G. K. Burgess. *Research Laboratory Rec.*, vol. 1, no. 3, Feb. 1932, pp. 93–97. Establishment of National Hydraulic Laboratory at the U.S. Bureau of Standards in Washington; plan drawings and specifications of floor space of new building.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

RAIN AND RAINFALL, MEASUREMENT. Instruments Used in Making Rainfall Records—I, *Water and Water Works Eng.*, vol. 34, no. 400, Feb. 20, 1932, pp. 53–55. Description of standard rain gage for daily records; standard gages for weekly or monthly readings; older forms of rain gages and their chief defects.

RUN-OFF. Rainfall Run-Off, G. S. Coleman. *Inst. Mun. and County Engrs.—Journal*, vol. 58, no. 18, Mar. 1, 1932, pp. 1403–1415. Study of intensity-duration run-off curves and construction of original run-off formulas for design of storm sewers.

SEISMOGRAPHS. Portable Seismograph for Recording Artificial Earthquakes, J. H. Jones and D. T. Jones. *Journal Sci. Instruments*, vol. 9, no. 1, Jan. 1932, pp. 8–16. Motion of pendulum is magnified by means of arrangement of two small magnets and soft iron element suspended on phosphor-bronze strip which is attached to pendulum; coupling of magnifying system to pendulum introduces couple which opposes restoring moment of pendulum and lengthens periodic time.

WATER SUPPLY, NORTH CAROLINA. Minimum Flow of North Carolina Streams, C. E. Ray, Jr. *Am. Water Works Ass'n—Journal*, vol. 24, no. 2, Feb. 1932, pp. 171–201 and (discussion) 201–203. Statistical study of the stream flow records of the state from 1889 to 1930; stream gaging operations; stream flow dependence; drought occurrences; minimum weekly discharge of larger streams; average low flow; range of minimum flow in mountains; relation between minimum weekly stream flow and size of drainage area.

INLAND WATERWAYS

IMPROVEMENT. Stabilization of Alluvial Rivers in India, G. Hearn. *Eng. News-Rec.*, vol. 108, no. 11, Mar. 17, 1932, pp. 393–395. Observations upon problems involved in checking the meanderings of rivers in alluvial plains as related to problems on the Mississippi; training river at bridges; characteristic river forms; stabilization of bends.

IRRIGATION

CANALS, DESIGN. Charts for Design of Irrigation Channels, F. A. Nevill. *Commonwealth Engr.*, vol. 19, no. 7, Feb. 1, 1932, pp. 239–242. Diagrams of discharge of concrete-lined and earthen channels.

MATERIALS TESTING

CEMENT. Cool-Room Cement Testing Necessary at Arizona Highway Laboratory, J. W. Powers. *Eng. News-Rec.*, vol. 108, no. 8, Feb. 25, 1932, p. 297. Summer temperatures necessitated the providing of an artificially cooled cement-testing room at the Arizona highway department laboratory at Phoenix.

MACHINES. Very Large Testing Machine. *Engineer*, vol. 153, no. 3971, Feb. 19, 1932, p. 220. Testing machine claimed to be the largest in the world completed by Baldwin-Southwark Corp., Philadelphia, for the laboratory of the University of California; designed to test in compression columns up to 33 ft. 6 in. long, and under loads up to 1,785 tons; in tension it will accommodate specimens with stretched length of 33 ft. 6 in. and can apply to them loads up to 1,340 tons.

ROAD MATERIALS. Effect of Heat Upon Certain Aggregates in Manufacture of Tar Macadam and Bituminous Macadam, B. H. Knight. *Surveyor*, vol. 81, no. 2091, Feb. 19, 1932, pp. 243 and 244. Fissuring and cleavages in granite; synthetic resin process for detection of fissures in stone.

MUNICIPAL ENGINEERING

PARKS, ELEVATORS. Notes on Design of Cliff Lifts, R. Agar. *Inst. Mun. and County Engrs.—Journal*, vol. 58, no. 18, Mar. 1, 1932, pp. 1416–1423. Types of lifts; electric tramway type; water-ballast type; tower-lift type; shaft and tunnel type; lift shaft.

PORTS AND MARITIME STRUCTURE

BREAKWATERS. Breakwaters for Protection of Harbors, W. B. Allen. *World Ports*, vol. 20, no. 3, Jan. 1932, pp. 193–200 and (discussion) 200–203. Harbors of the world which are dependent upon breakwaters for the protection of shipping; considerations in design; causes of failures; Los Angeles and Long Beach project. Before Am. Ass'n Port Authorities.

BRITISH EMPIRE. English Port Ownership and Control, D. Ross-Johnson. *Inst. Transport—Journal*, vol. 13, no. 3, Jan. 1932, pp. 107–114 (discussion) 115–126. Review of factors contributing to high costs in port operation; manner in which rival forms of transport had to be coordinated; concluding questionnaire regarding methods of reducing port operating costs.

JETTIES, CONCRETE. Jetty Works of Ford Motor Company at Dagenham, H. J. Deane. *Engineer*, vol. 153, no. 3971, Feb. 19, 1932, p. 205. Reinforced-concrete jetty for dealing with imports of ore and limestone in connection with the manufacture of the Ford Motor Company's cars and for export of the finished product. Before Inst. Civil Engrs.

ROADS AND STREETS

AUSTRALIA. Australian Road Practice and Experiments, T. J. Cavanaugh. *Eng. News-Rec.*, vol. 108, no. 8, Feb. 25, 1932, pp. 295 and 296. Lower-cost construction of oil, tar, and cement penetration and mixed-in-place bituminous surfaces; rubber bitumen mixture; bituminous macadam; surface applications.

BITUMINOUS. Discussion Concerning Adhesion Tension in Asphalt Pavements, V. R. Nicholson. *Road and Streets*, vol. 75, no. 3, Mar. 1932, pp. 136–138. First of series of three articles; properties of colloids; determining soil colloids by hydrometer; tests on sieved materials; influence of colloid on asphaltic mixtures made therefrom.

BRICK. Resurfacing Worn Concrete Pavements with Vitrified Paving Brick. *Clay-Worker*, vol. 97, no. 1, Jan. 1932, pp. 32–34. Illinois

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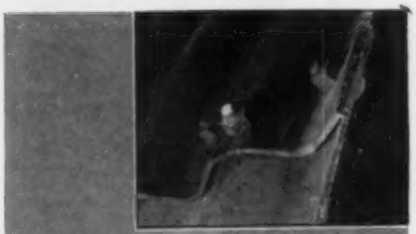

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CONCRETE. Proposed Specifications for Concrete Pavement in Municipalities. F. C. Lang. *Am. Concrete Inst.—Journal*, vol. 3, no. 7, Mar. 1932, pp. 453–478. Principles of design, alternates, and explanations; preparation of roadway; materials; pavement section; joints; forms; water supply; proportioning; mixing; depositing and finishing concrete; curing and protection; final acceptance.

COSTS. Comparative Costs of Four Types of Road Surfaces. W. W. Zass. *Eng. News-Rec.*, vol. 108, no. 11, Mar. 17, 1932, pp. 400 and 401. Charts showing accumulated costs per mile per year for gravel, gravel surfaced with asphalt retread, asphalt retread, and paved-road surfaces.

GRADING. Some Studies of Drilling and Blasting in Highway Grading. A. P. Anderson. *Pub. Roads*, vol. 12, no. 12, Feb. 1932, pp. 293–302 and 308. Study of 71 power-shovel grading jobs on which solid materials, requiring drilling and blasting, were encountered in considerable quantities; rate of production reduced more than 50 per cent by poor blasting; average rates of production and operation on 20 rock jobs; cost of shovel operation, improving quality of blasting; method for spacing drill holes; time loss; explosives used; locating blasting charge.

GRAVEL. Oil-Processed Road Economics in New Mexico. W. C. Davidson. *Eng. News-Rec.*, vol. 108, no. 9, Mar. 3, 1932, pp. 310–313. Conclusions based on records for 500 miles of roads; traffic capacity, maintenance charges, and costs compared with untreated gravel; choice of aggregates; oil requirements.

MATERIALS, BITUMINOUS. Recent Developments in Use of Tar for Road Purposes. W. R. Cone. *Surveyor*, vol. 81, no. 2094, Mar. 11, 1932, pp. 313 and 314. Types of tar macadam; determination of thickness; surface treatment; penetration method; tar emulsions.

NEW YORK CITY. Highway Construction in Borough of Queens. A. K. Johnson. *Mun. Engrs.—Journal*, vol. 17, paper no. 164, fourth quarterly issue 1931, pp. 149–172 and (discussion) 173–176. Statistical data and outline of engineering practice in construction and maintenance of system having total length of 730 miles; types of pavement; core requirements; grading Northern and Queens boulevards; grade separations; Indian cemetery; interborough parkway.

RAILROAD CROSSINGS, COSTS. Current Construction Unit Prices. *Eng. News-Rec.*, vol. 108, no. 11, Mar. 17, 1932, p. 418. Unit prices bid on extensive grade-crossing elimination project in Niles, Ohio, from West Second St. to West State St., over Mahoning River and tracks of Pennsylvania R.R.; contract was awarded for $278,255.

SIGNALS AND SIGNALING. Committee XII—Highway Crossing Protection. *Am. Ry. Ass'n Proc. (Signal Sec.)*, vol. 29, no. 1, Mar. 1932, pp. 372–375. Development on highway crossing protection; Federal and state activities.

SUBSOILS. Screen Aggregate Reduces Cost of Subgrade Stabilization. *Eng. News-Rec.*, vol. 108, no. 10, Mar. 10, 1932, p. 356. Experiments on South Carolina highways indicate a 50 per cent cut in haulage charges for screened aggregate and the effect on earth subgrade equal to that of pit-run material.

SWAMPS. Blasting to Settle Swamp Fills Approaches Rational Practice. M. W. Torkelson. *Eng. News-Rec.*, vol. 108, no. 10, Mar. 10, 1932, pp. 354–355. Progress in the technic of blasting as a means of sinking embankments of stable materials through soft and semi-fluid swamp soils; swamp-soil profile determined by sounding machine; loading diagrams developed in Wisconsin highway construction practice. Before Am. Road Builders' Ass'n.

SEWERAGE AND SEWAGE DISPOSAL

BIRMINGHAM, ALA. Wear Experiences in Storm Sewers Having Heavy Scour. *Eng. News-Rec.*, vol. 108, no. 10, Mar. 10, 1932, p. 357. Experience with joints of vitrified brick sewers in Birmingham, Ala., which have successfully withstood velocities of from 17 to 22 ft. per sec., since 1901.

DESIGN OF SEWERS. Design and Construction of Sanitary Sewers. C. A. Smith. *Mun. Sanitation*, vol. 3, no. 3, Mar. 1932, pp. 112–115. Importance of details; causes of troubles; causes of stoppage; depth; alignment and grades; sewer appurtenances; sewer construction; laying pipe; back-filling.

GAS PLANTS, WASTE DISPOSAL. Treatment of Ammoniacal Liquor from Gas Works. J. Slater. *Surveyor*, vol. 81, no. 2089, Feb. 5, 1932, p. 199. Effects of the presence of ammonia gas liquor on the treatment of dry weather sewage is reviewed in light of the experience at the Chorley sewage works; treatment of sand filters; strength of liquor. Before Ass'n Mgrs. Sewage Disposal Works.

INCINERATORS. Incinerator Fired by Digester Gas Burns Screening and Grease. W. A. Sperry. *Eng. News-Rec.*, vol. 108, no. 8, Feb. 25, 1932, p. 283.

NEW JERSEY. Underground Sewage Plant Serves Spring Lake, N.J. P. N. Daniels and C. H. Capen, Jr. *Water Works and Sewerage*, vol. 79, no. 3, Mar. 1932, pp. 87–89. Description of the sewage disposal plant of this Atlantic Ocean resort having a summer population up to 15,000; plant location and arrangement; sludge disposal by pumping into sea, preventing odor nuisance.

STORM. London, Too, Has Her Storm Sewage Problems. F. J. Taylor. *Mun. Sanitation*, vol. 3, no. 3, Mar. 1932, pp. 109–111. Original system completed in 1887 and now taxed to full capacity; construction details; storm-water pumping stations; sludge disposal.

STREAM POLLUTION, GERMANY. River Pollution Prevention in Ruhr Valley. *Surveyor*, vol. 81, no. 2091, Feb. 19, 1932, p. 249. Dr. Imhoff's report on the work of Ruhrverband during 1931; river surveys; sewage disposal works; artificial lakes.

WATER CHLORINATION, CONTAINERS. Method of Handling and Control of Chlorine in Ton Containers. M. C. Smith. *Water Works and Sewerage*, vol. 79, no. 2, Feb. 1932, pp. 63 and 64. Economy of 1-ton containers; routine of handling them.

UNITED STATES. Sewage Treatment in United States—Compared with That at Los Angeles Experimental Station. R. F. Goudey. *Water Works and Sewerage*, vol. 79, no. 3, Mar. 1932, pp. 67–70. Inspection tour of 31 of the most up-to-date sewage plants in the United States; principal points of difference in Eastern and in California sewage treatment; status of sprinkling filters; direct oxidation process; supremacy of activated sludge process.

STRUCTURAL ENGINEERING

BEAMS, CORRUGATED. Strength of Corrugated Steel and Iron Sheets Reviewed. R. Fleming. *Eng. News-Rec.*, vol. 108, no. 11, Mar. 17, 1932, pp. 399–400. Analysis of stresses in corrugated beams; safe-load tables based on formula published by Rankine in 1862; derivation of moments of inertia for use in flexure formula.

DESIGN. Calculation of Continuous Beams with Varying Moment of Inertia. A. J. Ashdown. *Concrete and Constr. Eng.*, vol. 27, no. 3, Mar. 1932, pp. 155–164. Theoretical mathematical analysis, tables of influence lines, and other design charts.

SURVEYING

AERIAL. Aerial Mapping—How It Is Done. L. T. Eliel. *West Flying*, vol. 11, no. 2, Feb. 1932, pp. 16–19. Principles and applications of aerial photography and surveying; use of stereoplotting machine; illustration of maps.

TUNNELS

PEDESTRIAN, CONCRETE PORTALS. Monolithic Concrete Tunnel Portals. L. H. Corning. *Constructor*, vol. 14, no. 2, Feb. 1932, pp. 20 and 21. Description of Sepulveda and Figueroa Street Tunnel portals, in Los Angeles, Calif.

SUBAQUEOUS. Belt Conveyors Handle Muck of Subaqueous Tunnel. *Contractors and Engrs. Monthly*, vol. 24, no. 3, Mar. 1932, pp. 19–23 and 31. Use of unique materials-handling method in East Boston traffic tunnel, which is 4,850 ft. in length and 21 ft. 6 in. wide; muck taken away from shield by a pair of apron conveyors connected to the shield and moved forward with it; operation of material locks; transformer station and compressor plant; grouting of tunnel; air lock precautions.

WATER SUPPLY, AUSTRALIA. Pressure Tunnel for Water Supply of Sydney, N.S.W. G. Haskins. *Engineering*, vol. 133, no. 3448, Feb. 12, 1932, p. 203. Tunnel was approaching completion when, in Sept. 1928, the rupture of a short concrete siphon under the Paramatta River, constructed on similar sandstone rock, led to doubts as to the safety of the tunnel; investigation was carried out to determine safety of structure; it was decided to strengthen the whole length with steel lining with internal diameter of 8 ft. 3 in. Before Inst. Civil Engrs.

WATER PIPE LINES

NEW YORK CITY. Steel Sheetpiling Carries Tunnel Through Fault Zone. *Eng. News-Rec.*, vol. 108, no. 10, Mar. 10, 1932, pp. 361–364. Construction of the Bronx River section of the new 21-ft. tunnel of the New York Water supply system; use of horizontal sheeting and extensive grouting successful in six months' fight to penetrate 50 ft. of soft ground, 500 ft. below the surface; steel piles are supported by rings of 10-in. H-beams; steel frame used to support hammer and sheetpiles for full-section enlargement; hammer riding around outside of frame ribs.

WATER PUMPING PLANTS

DIESEL. Brantford Uses Diesel Engines in New Water Works Station. *Power House (Eng.)*, vol. 25, no. 11, Nov. 1931, pp. 31–33. Three Diesel engines maintained as stand-by unit and also used for taking peak load from hydro when required in Brantford, Ont.; details of coagulating basin; engine particulars; lubrication system.

WATER RESOURCES

HAWAIIAN ISLANDS. Surface Water Supply of Hawaii, July 1, 1927 to June 30, 1928. *U.S. Geol. Survey Water-Supply Paper*, no. 675, 1932, 105 pp. Records of daily flow obtained at 83 stations operated during the year ending June 30, 1928, and results of miscellaneous stream-flow measurements.

WATER TREATMENT

ANALYSIS. Some Notes on Water Analysis. C. G. Gemmell. *Water and Water Eng.*, vol. 34, no. 400, Feb. 20, 1932, pp. 64–67. Calculation of results of analysis of waters by the usual methods does not always give an adequate presentation of the properties of the water; value of hydrogen-ion concentration as an indication of properties of any water supply.

IRON REMOVAL. Iron Removal Plant. M. F. Trice. *Water Works Eng.*, vol. 85, no. 6, Mar. 23, 1932, pp. 310–313. Description of plant at Warrenton, N.C., serving 1,000 persons; aerator consists of steel shell 10 ft. high and 7 ft. wide; mixing chamber is equipped with agitator; sedimentation basin; clear well; filter; total cost $7,396; plant efficiency. Before Am. Water Works Ass'n.

ODOR AND TASTE REMOVAL. Use of Ammonia at Tampa Water Purification Plant. J. E. Lyles. *Am. Water Works Ass'n—Journal*, vol. 24, no. 2, Feb. 1932, pp. 271–276. Experience with odor and taste removal by means of ammoniation and other processes; experiments with hydrogen sulfide waters.

SOFTENING. Fundamentals of Water Softening. A. M. Buswell. *Water Works Eng.*, vol. 85, no. 6, Mar. 23, 1932, pp. 306 and 307. Split treatment and results of combined treatment; misconceptions as to "temporary" and "permanent" hardness.

TURBIDITY. Tests for Turbidity. C. R. Cox. *Water Works Eng.*, vol. 85, no. 6, Mar. 23, 1932, pp. 314–316. Turbidity rod procedure; turbidity standards; preparation of standards; Baylis turbidimeter; submerged lights; floc detectors.

WATER WORKS ENGINEERING

CALIFORNIA. Chenery Project, California. E. K. Barnum. *Am. Water Works Ass'n—Journal*, vol. 24, no. 3, Mar. 1932, pp. 325–344. Description of system for augmenting the existing water supply of the California Water Service Co., serving sections of the industrial area along Suisun Bay in Contra Costa County, Calif.; Mallard pump station; Chenery reservoir, 215 acres surrounded on all but a portion of the south side by a rolled earth-fill embankment; filter plant; galindo booster plant; cost of project $1,430,297.

CASINGS. Factors Determining Well Diameter and Casing. A. Blakesley. *Am. Water Works Ass'n—Journal*, vol. 24, no. 3, Mar. 1932, pp. 375–377. Friction of casing; percolation; turbine installation; cost of well; drainage wells.

DESIGN. Objectionable Features Commonly Found in Water Works Systems. F. R. Daniels. *Am. Water Works Ass'n—Journal*, vol. 24, no. 3, Mar. 1932, pp. 382–385 (discussion) 385 and 386. List of fourteen groups of objectionable features.

NEW YORK. Water Supplies of Le Roy and Ticonderoga, New York. J. P. Wells. *Am. Water Works Ass'n—Journal*, vol. 24, no. 2, Feb. 1932, pp. 262–265. Description of two minor water works having a daily capacity of 1,000,000 and 1,200,000 gal.

NIAGARA FALLS, CANADA. New Pumping and Filtration Plant at Niagara Falls, Canada. *Eng.—Journal*, vol. 15, no. 3, Mar. 1932, pp. 144–157. Description of new water works plant designed for a rated capacity of 10,000,000 gal per day, capable of extension in the future to four times this amount; features of single supply main, concrete with steel core, 27 in. in diameter over 11,000 ft. long; provisions for coagulation, pumping raw water, mixing, sedimentation, filtration, and chlorination.

PARIS, FRANCE. Immense New Water Supply for Paris Authorized. *Eng. News-Rec.*, vol. 108, no. 9, Mar. 3, 1932, p. 316. Outline of project, including infiltration galleries in Loire Valley, to yield more than a quarter billion gallons of water daily, and 14½-ft. gravity-flow aqueduct, 90 miles long.

SANTA BARBARA, CALIF. New Emergency Water Supply for City of Santa Barbara. R. A. Hill. *West. City*, vol. 8, no. 2, Feb. 1932, pp. 9–13. Six gravel envelope-type wells drilled and pumping plant built; new surge suppressor prevents water hammer.

TOWERS, DESIGN. Monumental Water Tower Designed Against Earthquakes. A. Lindsay. *Eng. News-Rec.*, vol. 108, no. 8, Feb. 25, 1932, p. 282. Features of steel tank with a capacity of 1,250,000 gal., protected by a concrete enclosure, recently constructed in Spokane, Wash.; the tank is 78 ft. in diameter and 35 ft. high with a concrete inclosure rising 122 ft. 8 in. above ground surface.

WATERTOWN, N.Y. The Watertown Water System. H. J. Haley. *Am. Water Works Ass'n—Journal*, vol. 24, no. 2, Feb. 1932, pp. 249–258. History and description of system having an average daily consumption of 4,400,000 gal.; results of Pitometer survey.

WISCONSIN. Elevated Storage in Milwaukee. H. H. Brown. *Am. Water Works Ass'n*, vol. 24, no. 2, Feb. 1932, pp. 259–261. Description of tank of 1,500,000-gal. capacity, 79 ft. in diameter, with bottom 120 ft. above ground.